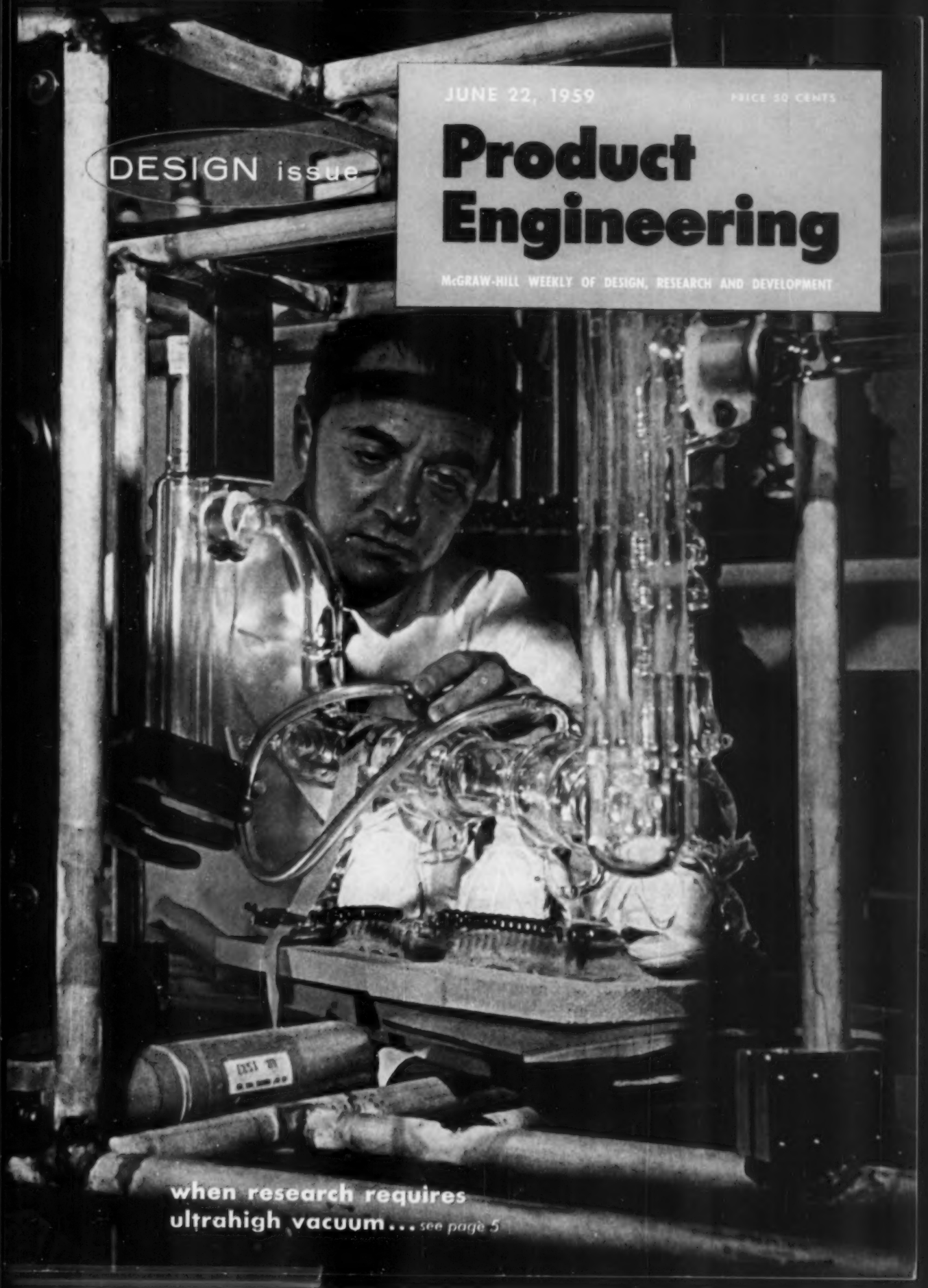
JUNE 22, 1959

PRICE 50 CENTS

DESIGN issue

Product Engineering

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT



when research requires ultrahigh vacuum... see page 5

Jet brake cup — LS-53
Synthetic lube diaphragm — LS-53
Diesel equipment seal — Viton
Chemical pump liner — Viton
Natural gas valve diaphragm — Viton

For advanced fuel...hydraulic...lube systems,

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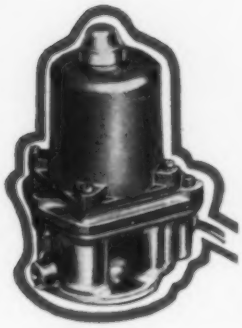
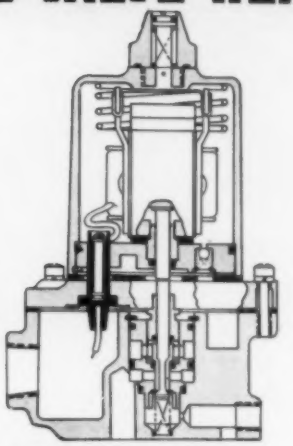
GOLDMODEL VALVE HEAD





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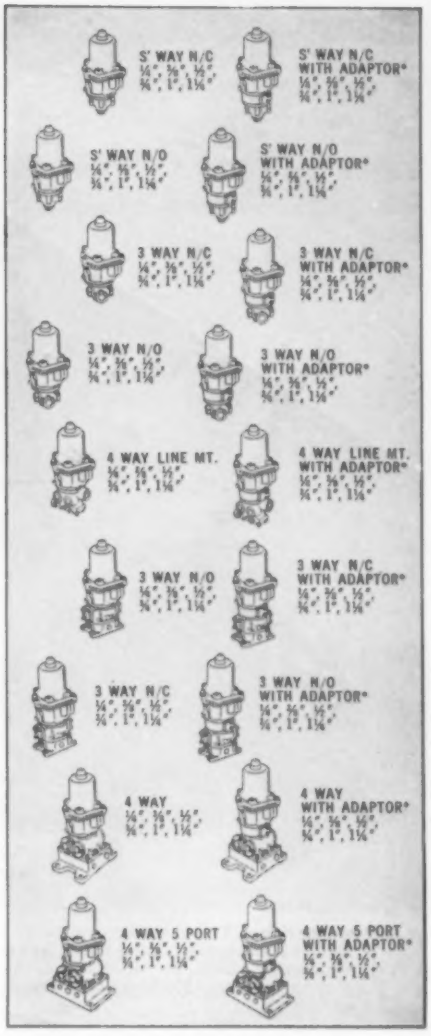
- The finest achievement in solenoid heads
- JIC
- Over 50 million cycles in tests
- Lightning fast

Modular construction is brought to the air valve field to give you the effect of a great valve inventory without stocking a great number of valves. Stock just one of these Goldmodel heads and you have the finest solenoid actuator obtainable for any one of the 54 Skyline bodies. This is the head designed especially for those uses where dependable performance and very long life must supersede all other considerations. The dustproof solenoid is the very finest and is immersed in oil to run cool and stay young. Write for bulletin 318.


5 WAY N/C
5 WAY N/C WITH ADAPTOR*
5 WAY N/O
5 WAY N/O WITH ADAPTOR*
3 WAY N/C
3 WAY N/C WITH ADAPTOR*
3 WAY N/O
3 WAY N/O WITH ADAPTOR*
4 WAY LINE MT.
4 WAY LINE MT. WITH ADAPTOR*
3 WAY N/O
3 WAY N/C WITH ADAPTOR*
3 WAY N/C
3 WAY N/O WITH ADAPTOR*
4 WAY
4 WAY WITH ADAPTOR*
4 WAY 5 PORT
4 WAY 5 PORT WITH ADAPTOR*

WHITEMODEL SPOOL SOLENOID
WHITEMODEL SPOOL SOLENOID MOMENTARY ADAPTOR
"featured above"
GOLDMODEL OIL-IMMERSED SOLENOID
GOLDMODEL OIL-IMMERSED SOLENOID MOMENTARY ADAPTOR*
SILVERMODEL JIC SPOOL SOLENOID
SILVERMODEL JIC SPOOL SOLENOID MOMENTARY ADAPTOR
GREENMODEL DOUBLE SOLENOID MOMENTARY
BLUEMODEL AIR OPERATED
BLUEMODEL AIR OPERATED MOMENTARY ADAPTOR
BLUEMODEL AIR OPERATED TIMED IN
BLUEMODEL AIR OPERATED TIMED OUT

"every head meets every body at this gasket"

ALL SKYLINE HEADS AND BODIES ARE BUILDING BLOCKS TO GIVE YOU MANY VALVES FROM A FEW HEADS AND BODIES

STRAIGHTWAY NORMALLY OPEN NORMALLY CLOSED
3 WAY NORMALLY OPEN NORMALLY CLOSED
4 WAY
3 WAY NORMALLY OPEN NORMALLY CLOSED
4 WAY
4 WAY 5 PORT

STAY AHEAD

MODERNIZE

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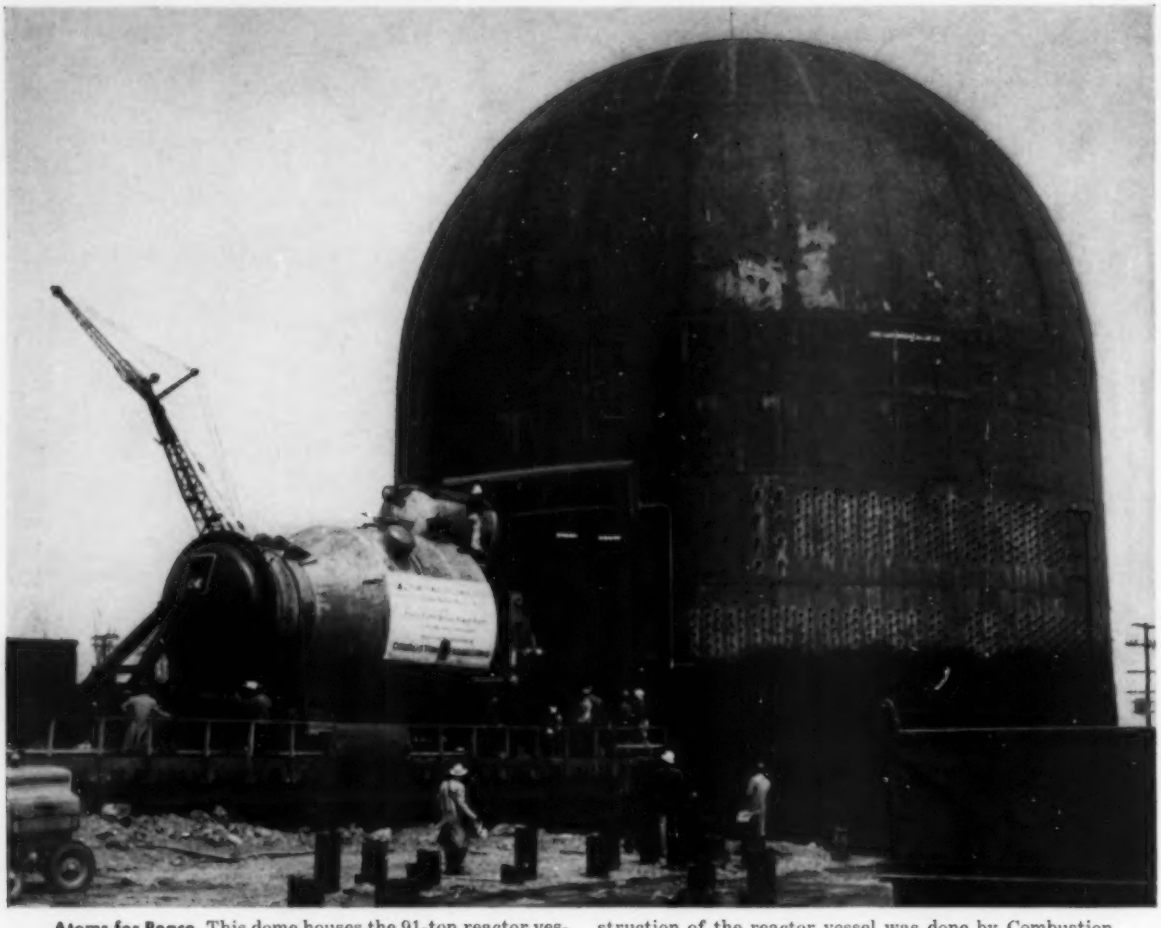

Atoms for Peace. This dome houses the 91-ton reactor vessel made of nickel-containing stainless steel for the new Enrico Fermi Atomic Power Plant on the shore of Lake Erie near Monroe, Michigan. Detail design and construction of the reactor vessel was done by Combustion Engineering, Inc. Plant will be built and operated by Power Reactor Development Company from designs supplied by Atomic Power Development Associates, Inc.

Atomic reactor "breeds" its own fuel

Stainless steel vessel must withstand high temperatures and corrosives

The world's largest full-scale nuclear reactor of the "fast-breeder" type is now being built. It may well answer the question:

> *When will atomic power be competitive with conventional methods of producing electric power?*

As the term "fast-breeder" indicates, the atom-splitting process is maintained by so-called *fast* or high-energy particles. It produces more nuclear fuel than it consumes. The fast-breeder actually turns out a kilogram and a fifth of new fuel for each kilogram it burns up!

The "breeding" takes place in a 36-foot high pressure vessel. Here, the high-energy particles (neutrons) travel at speeds of thousands of miles per second to keep the atom-splitting chain reaction going.

Accent on safety. A major objective was to make this reactor vessel safe. That called for a lot of highly specialized work.

It also called for a rugged metal: one capable of withstanding the tremendous heat given off in nuclear fission, and of bearing up under the temperatures and corrosives encountered. The final choice? Strong, corrosion-resisting Type 304 stainless steel. It's a stainless steel that contains Nickel – one of the big reasons for these superior properties.

How to "fast-breed" ideas. Problems involving reactor materials may never be a concern of yours. But you can run into *metal selection problems* involving corrosion, pressures, high temperatures and other destructive conditions almost any time. When you do, remember there is a good chance that a steel containing Nickel will provide the properties you want. Let us help you find out.

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Product Engineering

McGRAW-HILL WEEKLY OF DESIGN RESEARCH AND DEVELOPMENT

DESIGN issue

June 22, 1959 Vol. 30, No. 25

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small Gears . . . very small Gears . . . extremely small Gears . . .

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Interesting to Note . . .

Light in a Flash

"Night photography is given a new impetus by the noiseless, smokeless, nonflammable, weatherproof and foolproof characteristics of a new electric flash bulb. The device consists of a pear-shaped bulb containing a very thin aluminum foil and pure oxygen to provide for combustion . . ." This excerpt from the back pages of *Electrical World*, Nov 29, 1930, introduced a new era in American photography. Flashbulbs were invented the previous year in Germany by J. Ostermeier, but the American announcement of flashbulbs, by General Electric, put an end to the dangers and other problems of flashpowder. It also widened the field that fraternity of amateurs known as shutterbugs.

Now the common flashbulb is slowly being phased out by new stroboscopic and electronic developments. Tomorrow it may be ultrahigh-vacuum bulbs. Our cover shows final adjustments being made on an ultrahigh-vacuum test apparatus by H. H. Hroch, research engineer at Minneapolis-Honeywell's Heiland Div plant in Denver. Designed and built by Heiland researchers, the system is used in advanced research on electronic photoflash tubes and the recording lamps used in the company's line of direct-recording oscillographs known as Viscorders.

Oil's Well . . .

A gold strike 110 years ago brought such pandemonium to the California territory it was boasted that such excitement couldn't happen again for another century. Then, just 10 years later, silver was discovered in Nevada, the Comstock Lode found its place in our language, and the mad rush for claims once again hit the West.

And then, before prospectors could say, "It will never happen again," it did . . . several months later—exactly 100 years ago, Col E. L. Drake hit oil in the little Pennsylvania town of Titusville.

For centuries, the smelly black fluid that occasionally found its way to the surface of the earth was mainly a source of trouble. Settlers drilling for salt-carrying water often had to abandon their wells when it became contaminated by a foul-smelling mineral oil. Northeastern Indian tribes ran into the same stuff—but when they found the black grime floating atop shallow pools, they used a blanket to separate the oil from the water. This natural mineral

(CONTINUED ON PAGE 7)

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NEW ALCOA PRESSURE BONDING OFFERS UNIQUE DESIGN POSSIBILITIES

New Toastmaster fry pan combines aluminum and stainless steel for fast heating and easy cleaning

Alcoa's new process for pressure bonding aluminum to other metals paves the way for many new uses of aluminum in bimetallic products. The process, which requires neither flux nor molten metal, is accomplished in a die using heat and pressure to form a strong, ductile bond. It has already proved successful in bonding aluminum alloys to carbon and alloy steels, and stainless steel.

Typical of the unique applications opened up by this new Alcoa process is the Toastmaster* automatic fry pan. "Alcoa's new bonding process solved a long-standing problem for us," says Mr. Murray Ireland, president of the Toastmaster Division of McGraw-Edison Co. "We now have a fry pan that combines the even, fast heating of corrosion-resistant aluminum with stainless steel."

Other promising applications for the new pressure bonding process include: steam irons, cooking utensils and chemical handling equipment. For complete information on these and other exciting new design possibilities available to you for your products, contact your nearest Alcoa sales office. And for FREE books, films and help with any aluminum joining problem, write: Aluminum Company of America, 1760-F Alcoa Building, Pittsburgh 19, Pa.

*Registered Trademark of McGraw-Edison Company

Photomicrograph (arrow, top) shows fusion of aluminum alloy and stainless steel, using new Alcoa pressure bonding.

Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM

For Exciting Drama Watch "Alcoa Theatre," Alternate Mondays, NBC-TV, and "Alcoa Presents," Every Tuesday, ABC-TV

Interesting to Note . . . . (CONTINUED)

1859—Col E. L. Drake (tall hat) stands near his wooden rig.

oil was bottled and sold as a "snake-oil" or "Seneca oil."

While applications for petroleum were practically nonexistent in the mid-19th century, an interesting economic development occurred in a small New England town. New Bedford was the center of the whale oil industry—80% of which was controlled by a few men. They outfitted the whaling ships, hired the crew and sold the oil. Soon enough, they became greedy; without competition, they could boost the price of their oil as high as the market would bear. Because whale oil was the best available source of lighting, the public had little choice.

A substitute for whale oil was meanwhile trying to get on the market. This new oil, distilled from coal and called kerosene, wouldn't sell because of its vile odor. But another candidate was in the making. Several years earlier, Samuel M. Kier had been disappointed when he found oil coming out of one of his salt wells on the Allegheny River. He sent a sample to the state university and was told that if he could refine the oil he'd have an excellent lamp fuel. From 1850 on, he was able to crudely refine and sell all the oil he produced from his salt well. Then two New Yorkers, George Binell and Johnathan Eveleth, hit upon the novel idea of drilling for Pennsylvania oil with the same derricks being used for salt. As a partner and field superintendent they hired an ex-railroader, Col Edwin L. Drake.

It took a year and a half but in the summer of '59 Drake's well in Titusville hit oil. Word of the strike, together with Kier's method of refining, meant one thing—whale oil could be replaced

Following the excitement some of the more thoughtful citizens began to ponder the mystery of petroleum.

One man suggested the oil had been stored underground—to be used to destroy the world. Another asked legislators to prohibit further drilling because oil was used to light the fires of Hell—and these punishing flames would die down if drilling continued. A clergyman informed President Lincoln that the petroleum was used to grease the axletree of the earth as it revolved. Ironically, these early theories may contain a little truth. Petroleum does power our warships and planes; and although the earth may not revolve on grease, few moving mechanical parts can get along without a lubricant. The article on page 64 describes a new test for coefficient of friction when extreme-pressure lubricants are used.

What Next for Aluminum?

Aluminum, one of today's most versatile metals, was once as valuable as gold. Then the Hall process and later technical developments (p 76) allowed the silvery metal to be produced inexpensively and in a multitude of forms. Aluminum film is being casually discarded by housewives throughout the country while a thin film of aluminum inscribed with 30,000 or more lines per sq in. gave help in space-radiation studies during the IGY. Another new application of aluminum is reported from the Polynesian Islands. Bands of lightgage sheet are wrapped around coconut trees, presenting slippery footing for tree-climbing rodents that like nothing better than to raid the islands' vital copra and coconut crop.

Hospitals have found that lightweight aluminum pie plates can also be substituted as a shield for body burns. These plates, padded at the edges, are taped over the burned area to keep the seared area free from contact with clothing.

Aluminum has its drawbacks too. Students living in Marquette University's new dormitory were horrified to find they could get into their rooms but couldn't get out. It seems the new aluminum doors were equipped with special locks—intended for a local mental institution but mistakenly installed at the university.

Builder of Better Boxes

In 1920, Raymond DeWalt was a superintendent at Seabrook Farms. One of his big problems was making sure there were always enough boxes available to crate the fresh produce; for this, boxes were constantly being built on the premises. But only table power-saws and handsaws were available, so box making was slow and arduous—at times, vegetables spoiled while waiting for a box to be built.

This was a thorn in DeWalt's side. Why couldn't someone develop a power saw that would do the moving—rather than maneuver wood over to a stationary blade? He worked on the problem and, in 1922, developed a radial arm saw. Now he could cut more boards faster, safer and with far greater accuracy than before. His friends then wanted him to build such saws for them. The following year, he had so many orders, he left Seabrook farms and established the DeWalt Mfg Co, building only radial saws. Now the company is a division of AMF, turning out equipment for the home workshop and industry. The newest in a radial saw is described on page 72.

—Benedict A Leerburger Jr

New from HOWARD...a Complete

- **UNIVERSAL**
- **SHADED POLE**
- **INDUCTION**

Ratios from 3:1 to 2700:1

Shown on these pages are just a few of Howard's gear motors. Thousands of combinations and ratios are available in universal, shaded pole and induction types. If your product requires gear motors, check today for complete information. Give us details of your application and quantities required and we will be happy to submit samples and quotations or more information on standard types available.

MODEL 300

TYPE: Two Pole Shaded Pole AC—3200 R.P.M.

WIDTH: 2-15/32". LENGTH: 3-7/8".

MAXIMUM CONTINUOUS TORQUE OZ. IN. (at 11/16" Stacking Length).
*1 R.P.M. 500 oz. in.
*150 R.P.M. 3.3 oz in.

MAXIMUM INTERMITTENT TORQUE OZ. IN. (at 11/16" Stacking Length).
*1 R.P.M. 750 oz in.
*150 R.P.M. 5 oz. in.

VOLTS: 12 to 115.

BEARINGS: Porous bronze sleeve bearing with oil reservoir.

*Torques at intermittent speeds are inversely proportional to speed.

MODEL 3000 with GEAR UNIT

TYPE: 2 Pole Shaded Pole.

DIAMETER: 3-7/16".

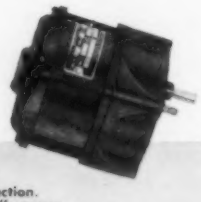
LENGTH: 3-5/8" to 4-1/2".

MAXIMUM CONTINUOUS TORQUE* 1 R.P.M. (at 1-1/2" Stacking Length): 45 in. lbs.

MAXIMUM INTERMITTENT TORQUE* 1 R.P.M. (at 1-1/2" Stacking Length): 70 in. lbs.

BEARINGS: Porous bronze sleeve type with oil reservoir.

*With external fan. Torques at other speeds from 1 to 400 rpm available upon request.



MODEL 2400

TYPE: 4 Pole Induction.
DIAMETER: 2-9/16" square.

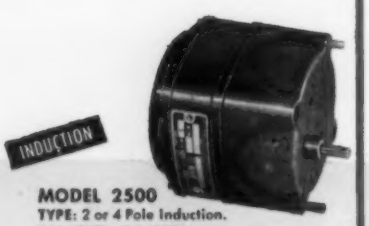
LENGTH: 2-3/8" to 3".

SINGLE PHASE CAPACITOR MOTOR:
Maximum Torque oz. in.—1.
Full Load Speed R.P.M.—1150.
Bearings—RBC—Ball. RWC—Sleeve.

TWO PHASE MOTOR:
Maximum Torque oz. in.—1.5.
R.P.M.—1150.
Bearings: RBT—Ball. RWT—Sleeve.

BEARINGS: Porous bronze sleeve type with oil reservoir, or grease sealed ball bearings.

GEAR UNITS: Ratios 6:1 to 3600:1. Spur gears throughout. The high speed pinion is cut on the shaft, assuring accuracy and concentricity, and maximum strength is achieved by supporting the output shaft in large porous bronze bearings.



MODEL 2500

TYPE: 2 or 4 Pole Induction.

DIAMETER: 2-9/16" square.

LENGTH: 1-7/8" to 2-3/8".

SPEED: *1200 to 3600 R.P.M.

H.P.: 1/300 to 1/1400.

MAXIMUM TORQUE oz. in. *1.6 to 3.5.

BEARINGS: *Ball or sleeve.

*Dependent on type of motor used; i.e. Non-Synchronous Capacitor Motors, Torque Motors, Standard Synchronous Motors, Hysteresis Synchronous Motors.

GEAR HEAD: Ratios from 6:1 to 3600:1. Torques up to 300 in. oz. at low speeds. Range of output speeds from ½ r.p.m. to 600 r.p.m.

Spur gears are used throughout. The high speed pinion, cut on the rotor shaft, assures extreme accuracy, and maximum strength is achieved by supporting the output shaft in large, solid bronze bearings.

MODEL 2900 with GEAR UNIT

TYPE: 2 Pole, 4 Pole Induction.

DIAMETER: 3-5/16".

LENGTH: 7-5/64" to 8-11/64".

SPEED: 1650 to 3600 R.P.M. depending on type of motor used—Non-Synchronous, Standard Synchronous, Hysteresis Synchronous, or Torque.

H.P.: 1/70 to 1/15 depending on length of stacking.

TORQUE OUTPUT: Up to 60 in. lbs. depending on ratio.

BEARINGS: Permanently lubricated and sealed ball bearings.

RATIOS: 10:1 to 60:1.

MODEL 29-500 with GEAR UNIT

TYPE: Universal AC/DC or Shunt.

DIAMETER: 3-5/16".

LENGTH: 7-13/64" to 7-37/64".

SPEED: 5000 to 10,000 RPM.

H.P.: 1/70 to 1/4 depending on length of stacking.

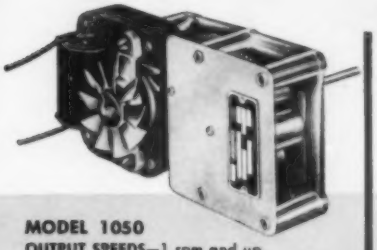
TORQUE OUTPUT: Up to 60 in. lbs. depending on ratio.

BEARINGS: Permanently lubricated and sealed ball bearings.

RATIOS: 10:1 to 60:1.

line of Fractional H.P. Gear Motors

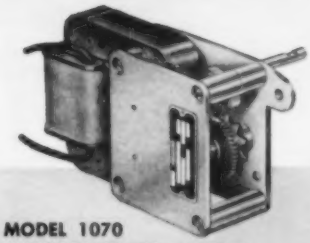
2 POLE, DOUBLE BEARING



MODEL 1050

OUTPUT SPEEDS—1 rpm and up.
GEARS—Molded nylon in high-speed for quiet operation, stamped, cut or sintered in low-speed section.
BEARINGS—Sintered porous bronze with large oil reservoirs for assured self lubrication.
MOUNTING—Front only; choice of ten holes tapped as required.
ROTATION—Unidirectional (CW or CCW).
SHAFT—3/16 in. dia. std. with length to meet requirements.

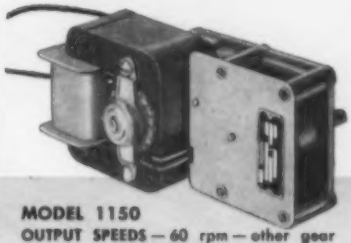
starting torque, in. lbs.	no load rpm	full load					stock A. in.
		torque, in. lbs.	rpm	input (115-V) amps.	input (115-V) watts	gear ratio	
20	6.8	33	6	.34	18	500:1	⅛
15	10.2	24	9	.34	18	333:1	⅛
7	17	19	15	.46	24	200:1	⅛
5	43	11	30	.46	24	100:1	⅛
2.25	75	4.5	68	.46	24	45.4:1	⅛
2.0	122	2.4	108	.75	35	27.8:1	⅛
1.5	159	1.9	140	.81	40	21.4:1	⅛



MODEL 1070

OUTPUT SPEEDS—30 rpm and up.
GEARS—Molded nylon in high-speed section for quiet operation; stamped, cut or sintered in low-speed section. Also available, when specified, with cut gears throughout.
BEARINGS—Sintered porous bronze with large oil reservoirs for assured self-lubrication.
MOUNTING—Front only; choice of three holes tapped #8-32 and/or two .161 in. dia. holes.
ROTATION—Unidirectional (CW or CCW) as specified.
SHAFT—3/16 in. dia. std. with length to meet requirements.

starting torque, in. lbs.	no load rpm	full load					stock A. in.
		torque, in. lbs.	rpm	input (115-V) amps.	input (115-V) watts	gear ratio	
2.25	82	4.5	74	.46	24	37.8	⅛



MODEL 1150

OUTPUT SPEEDS—60 rpm—other gear trains for different output speeds available, state requirements.
GEARS—Molded nylon in high speed section for quiet operation. Stamped, cut or sintered for low-speed section.
BEARINGS—Sintered porous bronze with large oil reservoir for assured self-lubrication.
MOUNTING—Front only, choice of ten holes tapped as required.
ROTATION—Unidirectional (CW or CCW as specified).
SHAFT—1/4 in. dia. std. with length to meet requirements.

starting torque, in. lbs.	no load rpm	full load*					stock A. in.
		torque, in. lbs.	rpm	input (115-V) amps.	input (115-V) watts	gear ratio	
16	75	24.5	60	3.1	124	50:1	1¼

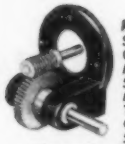
*Intermittent duty (10 seconds On, 30 second OFF continuously).

GEAR REDUCTION UNITS

Designed for direct mounting on Howard motors, the speed reducers illustrated in this section give a wide range of speeds and torque in both open and closed types; single or two stage. Closed units are grease packed for efficient lubrication with minimum maintenance. For heavy duty, high torque applications, Models A-7 and A-12 are especially recommended. *Twelve Howard universal motors (not shown) are available as gear motors with the gear units illustrated.*

Hundreds of standard ratios permit accurate selection of output speed. Most of the gear units can be supplied with double shaft extensions where required. Our gear reducers are intended for use only with Howard motors.

Ratings are maximum under ideal operating conditions. Each application requires careful consideration based on having description of Load & Duty Cycle.



MODEL A-1
Single Reduction, Open
Maximum Ratio: 58:1
Minimum Ratio: 3:1
TORQUE
Continuous Duty: 5 in. lbs.
Intermittent Duty: 10 in. lbs.
Efficiency: Max. 45%

MODEL A-3
Double Reduction, Open, With Mounting Pad
Maximum Ratio: 2700:1
Minimum Ratio: 40:1
TORQUE
Continuous Duty: 5 in. lbs.
Intermittent Duty: 10 in. lbs.
Efficiency: Max. 30%

MODEL A-4
Single Reduction, Closed
Maximum Ratio: 58:1
Minimum Ratio: 3:
TORQUE
Continuous Duty: 5 in. lbs.
Intermittent Duty: 10 in. lbs.
Efficiency: Max. 45%

MODEL A-5
Double Reduction, Closed
Maximum Ratio: 2700:1
Minimum Ratio 40:1
TORQUE
Continuous Duty: 10 in. lbs.
Intermittent Duty: 20 in. lbs.
Efficiency: Max. 30%

MODEL A-6
Single Reduction, Closed
Maximum Ratio: 60:1
Minimum Ratio: 3:1
TORQUE
Continuous Duty: 12 in. lbs.
Intermittent: 25 in. lbs.
Efficiency: Max. 65%

MODEL A-7
Double Reduction Closed, Heavy Duty
Maximum Ratio: 2600:1
Minimum Ratio: 21.5:1
TORQUE
Continuous Duty: 50 in. lbs.
Intermittent Duty: 100 in. lbs.
Efficiency: Max. 50%

MODEL A-12
Combined Worm and Spur Gears
Maximum Ratio: 525:1
Minimum Ratio: 6.7:1
TORQUE
Continuous Duty: 100 in. lbs.
Intermittent Duty:: 250 in. lbs.
Efficiency: Max. 50%

MODEL A-26
Single Reduction, Closed
Heavy Duty
Maximum Ratio: 60:1
Minimum Ratio: 3:1
TORQUE
Continuous Duty: 50 in. lbs.
Intermittent Duty: 100 in. lbs.
Efficiency: Max. 80%

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STEEL SHAPED TO CUT COSTS AND IMPROVE PRODUCTS

A one-piece rail rolled for the runway of Cleveland Tramrail Systems. This track has flat raised treads designed to minimize peening. No machining is required on this USS Special Section.

Tramrail—non-peening, no machining made from USS Special Sections

This supply of rails for Cleveland Tramrail Systems represents a cost saving running into many thousands of dollars. They are USS Special Sections rolled to exact size and cut to proper length. If the rails had to be machined from bars of high-carbon or alloy steel, the cost would be prohibitive and scrap losses tremendous.

The steel is furnished in a high carbon grade which serves to minimize track wear caused by wheel peening on the track tread. The manufacturer says that in 30 years no other overhead track has been offered that surpasses this one for durability.

It's seldom that better products can be produced at substantially lower costs but that's what happens when you use rolled USS Special Sections. Rolled to the predominating cross section needed, it is a custom-tailored part, designed and rolled so that there is little or no finishing required to meet final specifications.

Why not find out what USS Special Sections can do for you? This is one *sure* way you can help to keep costs down and get faster production at the same time.

Write for our new book, USS Special Sections. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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Tennessee Coal & Iron—Fairfield, Alabama
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Technical data for gasket design and selection

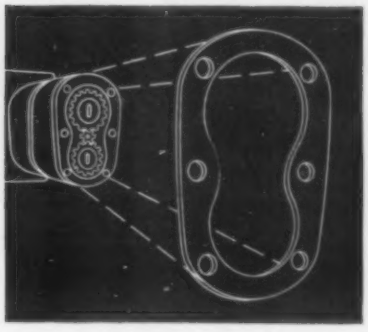
NUMBER TEN

How to be sure of dimensional stability in fiber gaskets

Dimensional stability in fiber gaskets is obviously important in assembly line production, where warped or shrunken gaskets can cause delays.

Although it is sometimes overlooked, this factor is equally important in gaskets sold for replacement purposes. Such gaskets are usually in dealers' stocks for long periods under varying conditions of temperature and humidity. Often they become unusable or fail to give satisfactory service when they are installed.

Shrinkage and warpage of conventional fiber gaskets stem from the fact that their saturant—usually a glue-glycerine solution—is extractable.



Conventional fiber gaskets on this food mixer dried out and leaked. Switch to Armstrong Accopac eliminated this problem.

This extraction can take place in a short time while the gasket is in service or over a relatively longer period if the gasket is in storage.

A maker of food processing equipment found an economical answer to this problem in Accopac N-852—an Armstrong beater-saturated gasket.

N-852 is made with a nitrile-type rubber binder that is non-volatile and non-extractable in any recommended application. Gaskets cut from N-852 are virtually unaffected by variations in temperature and humidity.

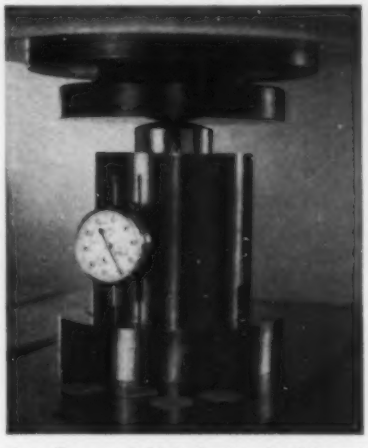
If the fiber gaskets you are using lack dimensional stability, or if they warp or get brittle with age, it is likely that N-852 or one of the other compounds in the Armstrong line will be the answer. We will be glad to suggest appropriate materials if you send details of your problem to us.

How to get lasting gasket seals on aluminum flanges at high pressures and temperatures

Where aluminum flanges are used—particularly at temperatures of 300° F. or above—some new problems in gasket engineering are encountered.

These problems are obviously related to the fact that aluminum's coefficient of expansion is roughly twice that of cast iron or steel.

As heat is applied to an aluminum assembly, expansion has the effect of substantially increasing the unit load above that required for sealing at room temperature. This higher load



Test jig on Baldwin-Southwark Universal Tester determines tendency of gasket samples to crush and extrude under high compression loads.

usually causes conventional fiber materials to crush and extrude, resulting in serious loss of bolt torque.

As the assembly cools to room temperature or below, the contraction of the aluminum often is greater than the gasket material can compensate for, and the result can be leakage.

Engineering studies on problems peculiar to aluminum flanges have been carried on at the Armstrong Research and Development Center for more than a year. These studies show that conventional fiber materials have a marked tendency to crush and extrude under heat and pressure. In fact, for many applications, these materials offer practically no safety factor.

MATERIAL	psi at 300° F		
	10,000	30,000	100,000
A	●	●	
B	●	●	●
C	●	●	

Test samples of conventional fiber materials (A and C) show extensive crushing at 30,000 psi. Accopac AN-890 (B) is not affected at 100,000 psi.

With the use of aluminum growing rapidly—and in applications that impose increasingly severe service conditions on the gasket—the need for a new material becomes obvious.

As a result, Armstrong research has developed a new beater-saturated asbestos gasket material—Accopac AN-890. This new product resists crushing and extrusion even under pressures of 100,000 psi at temperatures up to 350° F. It is already being used in a variety of critical aluminum flange applications.

If you are now working—or planning to work—with aluminum flanges, our experience may be helpful. We will be glad to make suggestions if you will submit details of your problem to us. Write Armstrong Cork Company, Industrial Division, 7106 Irvin Street, Lancaster, Penna.

Armstrong GASKET MATERIALS

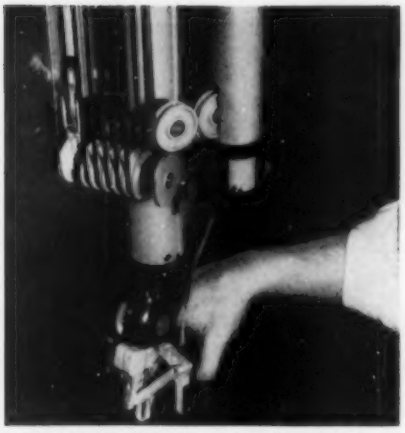
. . . used wherever performance counts

How NS solved another special steel problem

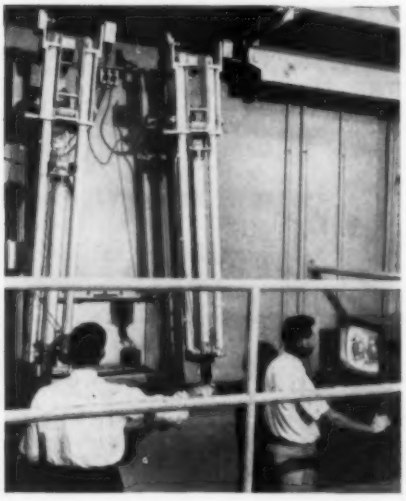
Photos courtesy of Nuclear Systems Division, The Budd Company

RADIOACTIVE MATERIAL is handled remotely by operator from behind three-foot thick lead-glass wall. Nilcor strips, which make quick, accurate system response possible, can be seen running vertically from pulleys just above operator's hands.

SPECIAL NS-ATHENIA STEEL PUTS LIFE IN ATOMIC-AGE ROBOT



HAND MOVEMENTS at operator end of master-slave system are translated without distortion, or time lag through seven Nilcor strips (shown in photo) that travel through 15-foot belt and pulley system.



To manipulate radioactive materials with lifelike dexterity, from the other side of a three-foot thick protective wall, requires robot controls with a high degree of precision and quick response.

Ordinary cable or belt arrangements gave too much stretch between the operator's "master" hand movements and the identical "slave" movement at the other end of the system. Movements had to be translated almost instantaneously and duplicated exactly at the slave end of the system. To help solve this problem, robot system manufacturers came to the Athenia Steel Division of National-Standard to find a strip material that would serve in the belt-and-pulley arrangement of the mechanism with minimum stretch and friction and without backlashing or overshooting.

NATIONAL-STANDARD ENGINEERS at Athenia in Clifton, N. J., recommended Nilcor* strip (basically a cobalt-chromium-nickel alloy) because of its high fatigue resistance, high tensile strength and exceptionally high corrosion resistance—plus less than ⅛-inch lateral sweep per 8-foot length when laying flat without tension. Experiments with .005 Nilcor strip in the robot systems showed an 80% reduction in stretch and 90% reduction in friction over standard wire materials.

EXPERIENCED ENGINEERING HELP of this kind, for jobs requiring specialty steel and wire to meet unique applications, is available to *you* from National-Standard. For the many thousands of applications where only specialty steel or wire will solve the problem, let National-Standard engineers go to work for you. Write for additional information to National-Standard Company, Niles, Michigan.

OPERATOR STATION, shielded by protective wall, has television monitor screen where action inside radioactive room is reproduced as operator manipulates controls of master-slave system.

*Trade Mark

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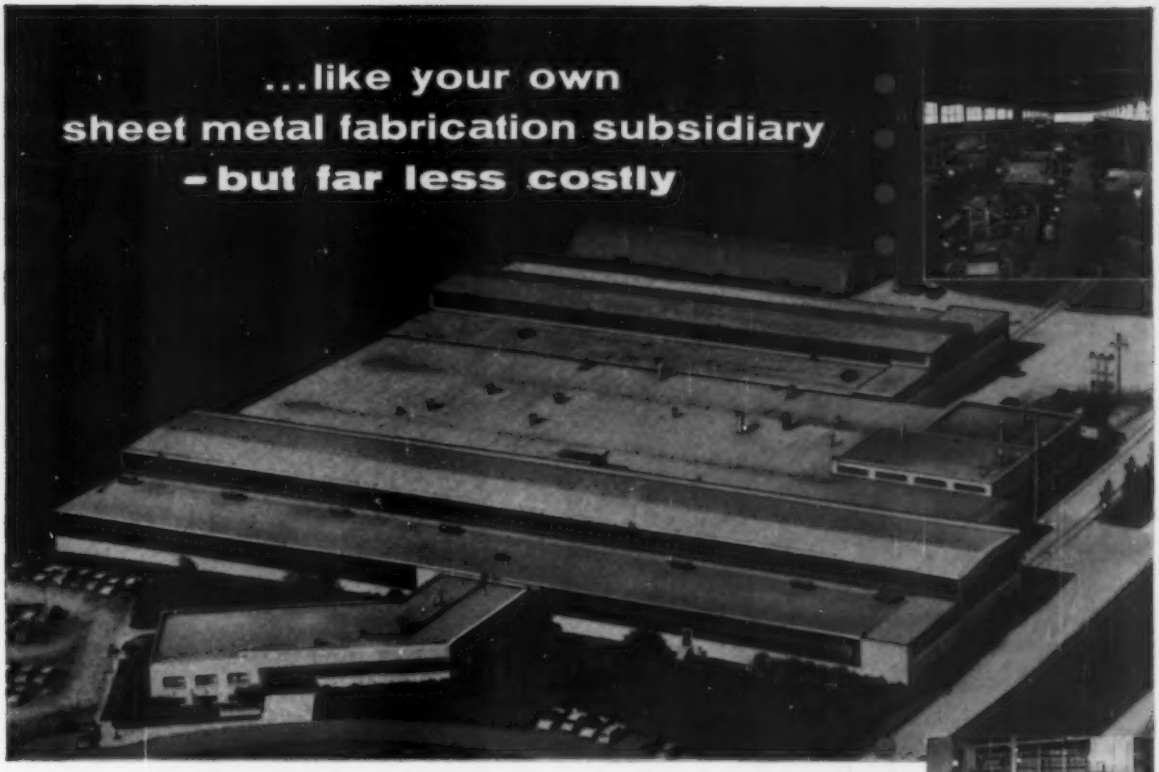

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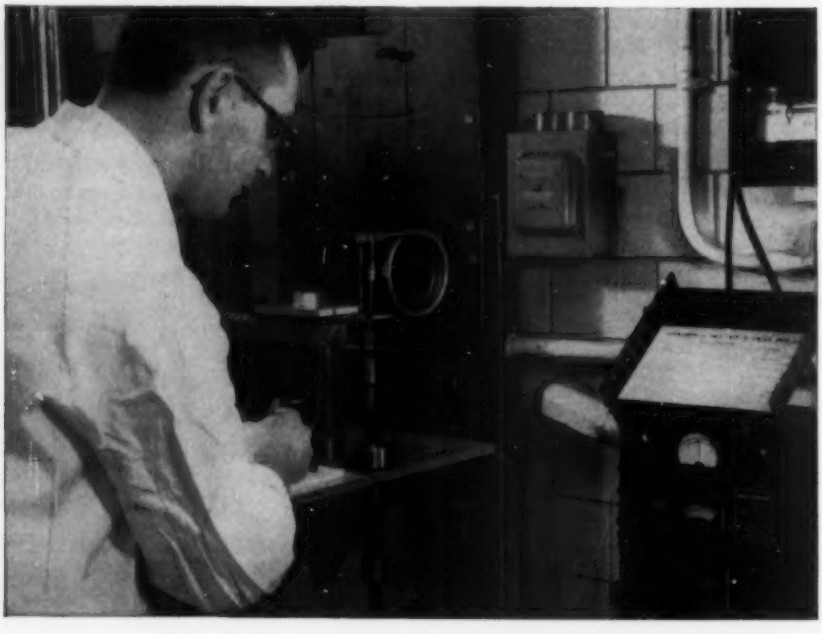
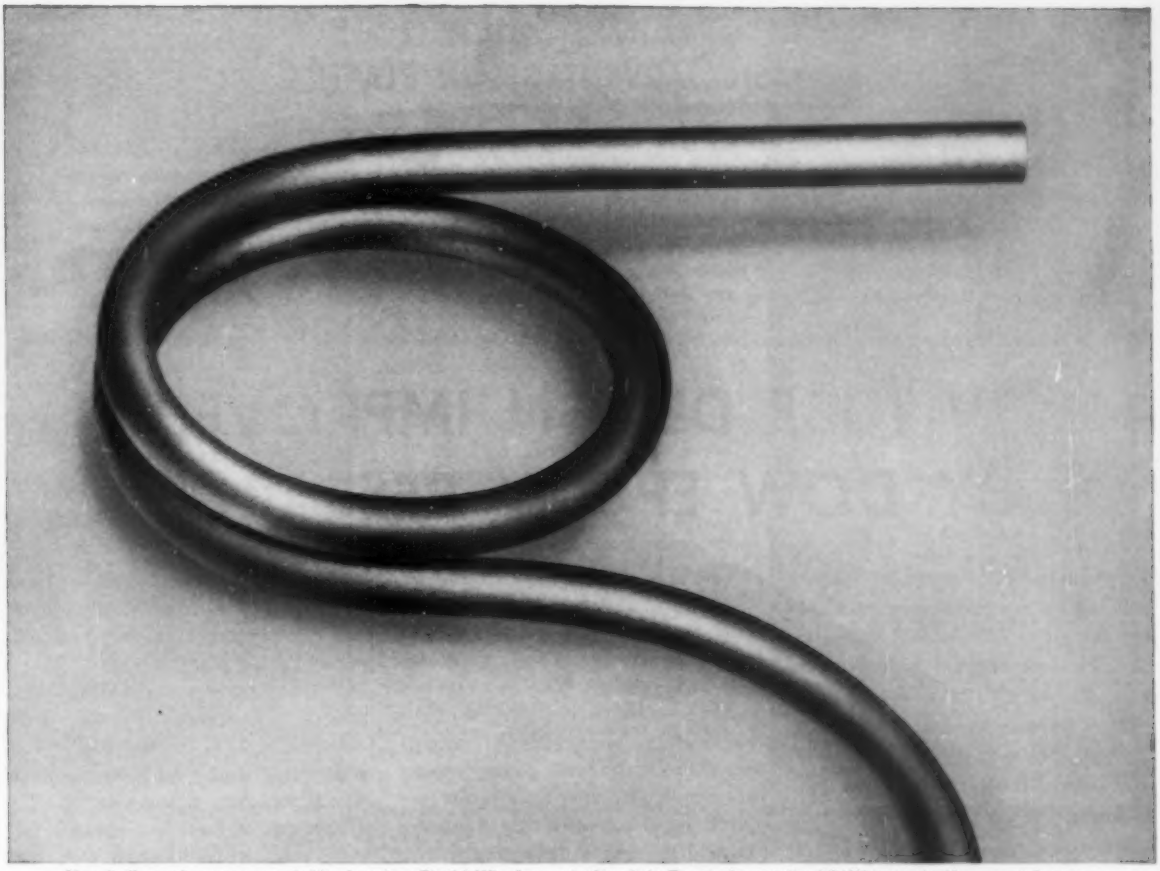
57

20,000 chairs rock on USS American Springs without one failure

...thanks to AS&W

In the American Steel & Wire Spring Testing Laboratory, the springs recommended for the Homecrest Chair go through extensive tests. This Fatigue machine, by means of strain-gauge verification, simulates years of use in a relatively short testing time.





Here is the spring recommended by American Steel & Wire for use in this chair. To supplement the AS&W tests, the Homecrest Company subjected these springs to a simulated rocking test. Under a weight of 250 pounds, these springs were rocked 750,000 times, without failure.

Spring Engineering Research Service

The Homecrest Company, Wadena, Minnesota, wanted to add a swivel rocking chair to their line of modern, functional home furniture. However, they would produce this chair only if it could be a quality item that would give good, dependable service. While designing the chair, they checked with the American Steel & Wire Spring Engineering Consulting Service. The engineers studied the problem, ran extensive tests and finally recommended a pair of round wire helical single coil torsion springs. Using these springs, Homecrest designed, fabricated and marketed the chair. Today 20,000 of these chairs have been sold and not one failure of an AS&W Spring has been reported.

Mr. A. L. Englemann, a partner of Homecrest Company, says, "We have purchased from American Steel & Wire over 45,000 springs, and not one has been reported a failure. We couldn't be happier with American Steel & Wire as a supply source for our springs."

If you have a spring problem, or would like advice on the use of springs in your product, get in touch with any American Steel & Wire Sales Office. You can benefit from the knowledge of AS&W's Spring Engineering Research Service. The Service has been engaged in laboratory experiments of static and dynamic testing for 20 years and has accumulated invaluable data on stress and fatigue life of steel springs, while endeavoring to improve efficiency in the use of steels, from steel chemistry through product application, to more economically cope with today's rigorous demands. This accumulated knowledge of the AS&W Spring Engineering Research Service is at your disposal. *American Steel & Wire, 614 Superior Ave., N.W., Cleveland 13, Ohio.*

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DOW | FOR "BASIC" ADVANTAGES IN PLASTICS

Sometimes a customer will ask the Dow representative, "So you're basic in epoxy resins and other materials—what does that mean to me?" The answer: Many quality advantages accrue to the buyer from Dow's complete control of all chemicals that go into the making of resins and thermoplastics. During the developmental stage, this *basic* position makes for better-controlled research; in the manufacturing stage, it makes for greater accuracy in translating research developments into production. The end result: improved quality and uniformity that Dow customers can turn into *basic* selling advantages . . . as illustrated on these pages.

TV-TUBE DESIGN IMPROVED BY DOW EPOXY RESEARCH

For years TV designers have been at work on the improvement of TV set design to eliminate certain inherent disadvantages and provide a less bulky set. TV and glass engineers have created a new method of lamination that brilliantly accomplishes long-standing design objectives.

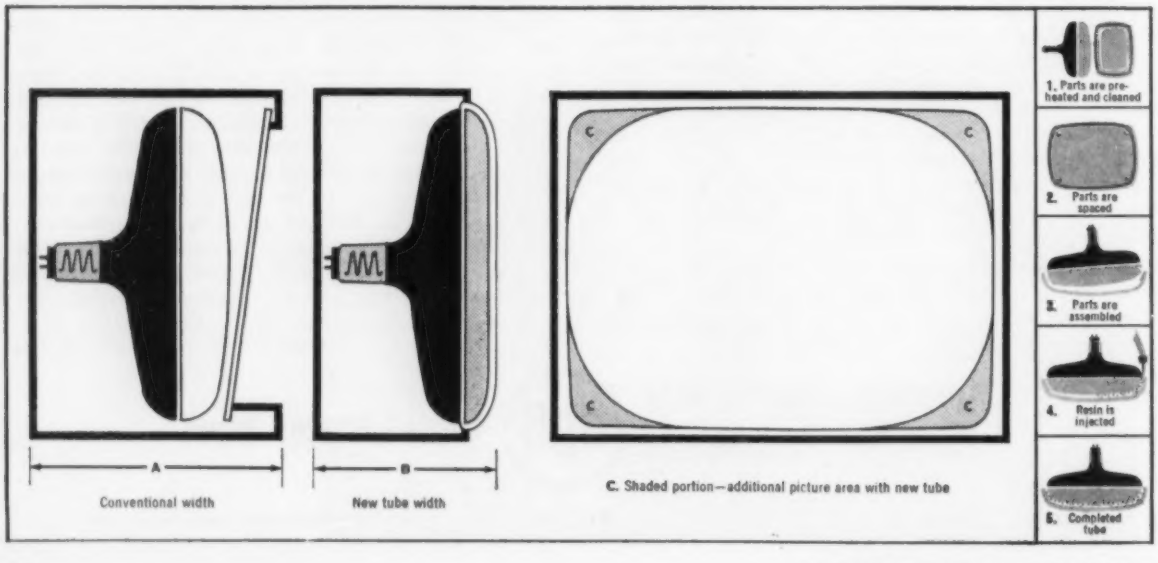
This latest example of the ability of Dow resin chemists to come up with major breakthroughs in plastics technology is a unique method of laminating a contour-fitted glass panel directly on the face of television tubes.

From the set designer's point of view, this allows reduction of the thickness of TV sets by inches and can provide new slim elegance for the set of tomorrow. Eliminating the separate panel of safety glass assures a *better, brighter picture* in two ways. First, the dead area between tube and conventional implosion panel is gone—entirely removing this dust-catching corridor. Second, a brighter TV picture results because elimination of the separate implosion panel increases light transmission and removes a distracting source of reflection between tube and panel.

Greater usable picture area on the tube is now possible also, because of the increased strength of the tube face provided by the new lamination with Dow epoxy resin. Up until now, TV tubes have been circular or oval in shape, masked by the set frame to appear square. With this new Dow lamination, the design of a virtually square tube becomes practical—and increased picture fidelity a reality.

This TV industry advancement was made possible in part by the *basic* position Dow holds in the manufacture of epoxies—including those used in making this new type of laminate.

The special facilities required for epoxy resin research—along with the know-how necessary to translate research results into production in minimum time—have been busy for years at the Dow laboratories in Midland, Michigan and Freeport, Texas. Right now, perhaps, they are working on problems of interest to your business. Why not investigate—today?



TYRIL® ***takes wide range of temperatures.*** Tyril, a recent development in the Dow family of thermoplastics, is providing both the manufacturer and the user of the milk dispenser shown here, with a "new look". Tyril has excellent resistance to temperature extremes. To the housewife that means trouble free service in the refrigerator, beauty on the shelf; yet at dishwashing time it can stand scalding hot water. To the manufacturer, the exceptional dimensional stability of Tyril permits close tolerances in moving parts.

TOUGH TACKLE ***for outdoorsmen***

Perhaps no one is more susceptible to something new than the fisherman. Yet he demands that it be trouble free. Again, out of the family of Dow plastics, another manufacturer found the material that provided the perfect combination of newness and functionality. In designing the handle and reel housing of this fishing outfit, the designer chose Tyril. Superior toughness, resistance to heat and cracking pay off for the fisherman. Its excellent molding characteristics and machinability pay the manufacturer in production economies.

OTHER DESIGNS

utilizing America's first family of thermoplastics

ETHOCEL—This control wheel for pump or lathe can really take rough and tumble shop service. It's made of Ethocel®, strongest, most durable thermoplastic on the market!

POLYETHYLENE—Here's a lightweight, rustproof minnow bucket that always floats upright. Designed in several of the many "built-in" colors possible with multi-range Dow polyethylenes.

TYRIL—A quality insulated serving jug and matched insulated tumblers made of Tyrill Smooth, semi-lustrous finish in a wide color selection. Won't absorb food odors.

STYRON—Several formulations were used in these colorful fishing lures: general purpose Styron for decorative characteristics, high impact Styron for strength.

FOR MORE INFORMATION

—about the versatile Dow plastics and the product designs discussed here, write to us today. THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Department 1710DZ6-22.

INDUSTRIAL MOLDING MATERIALS

PACKAGING MATERIALS

PAINT AND COATING MATERIALS

BUILDING PRODUCTS

THE DOW CHEMICAL COMPANY
Midland, Michigan

DOW

B.F.Goodrich

RIVNUTS®

give casual furniture fast selling luxury look

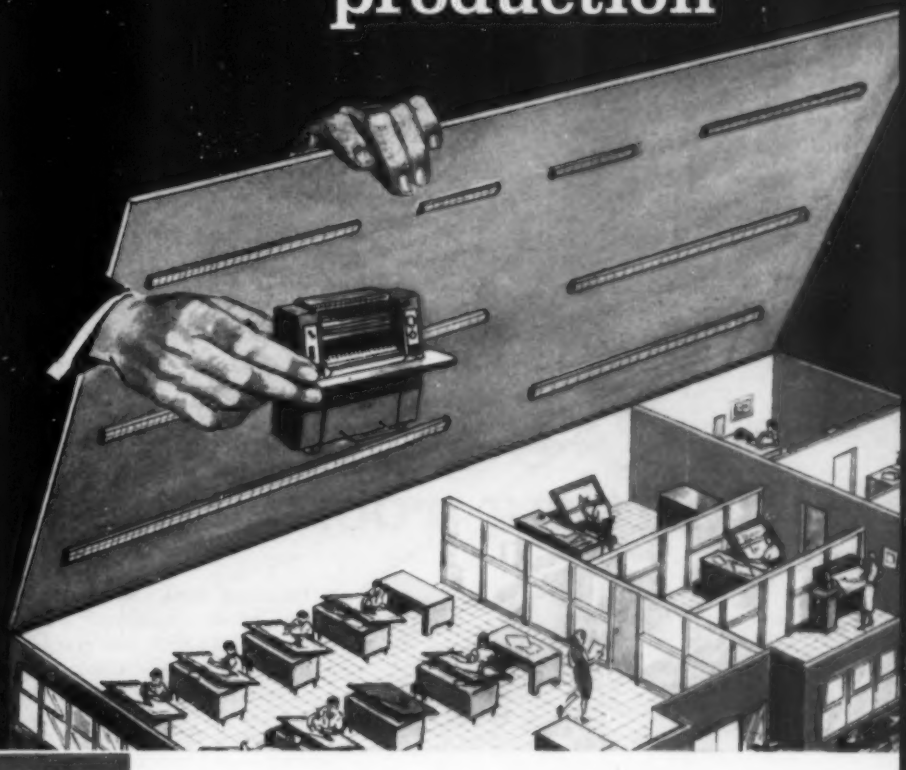
Durham Manufacturing Corporation preserves the clean, functional lines of its modern tubular furniture with B.F.Goodrich Rivnuts. Rivnuts eliminate unsightly nuts and bolts, speed assembly, add sales appeal.

Durham switched to B.F.Goodrich Rivnuts at key points in its complete line of casual furniture, including the inviting DURelaxer above. Rivnuts with countersunk heads are upset inside the tubular legs (see drawings). They provide high-strength nutplates for unobtrusive attachment screws. Crimped, lock-type ends prevent screws from backing out.

Only B.F.Goodrich Rivnuts give you firm, blind nutplates for tubular applications. So if you want to do a smoother fastening job, or want to fasten faster and at less cost, use B.F.Goodrich Rivnuts. Send now for free data booklet. *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. PE-69, Akron, Ohio.*

B.F.Goodrich *aviation products*

how the Bruning Man raises the "ceiling" on drafting room production



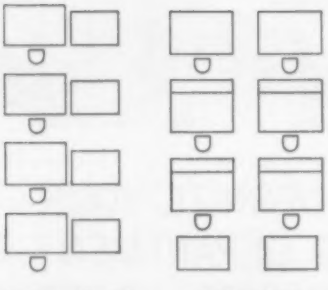
BRUNING

5 WAYS TO MODERNIZE YOUR DRAFTING DEPARTMENT FOR MORE MANPOWER, LOWER COSTS

In this era of fast, intense, and ever-changing engineering progress; drafting departments are being called on for faster, more accurate work. Costly expansion need not be the only answer. Read on the following pages how the Bruning Man's reasonably priced modernization program will more than pay for itself in greater production and lower costs.

modernize to make 50% more productive use of space with

drafting room furniture



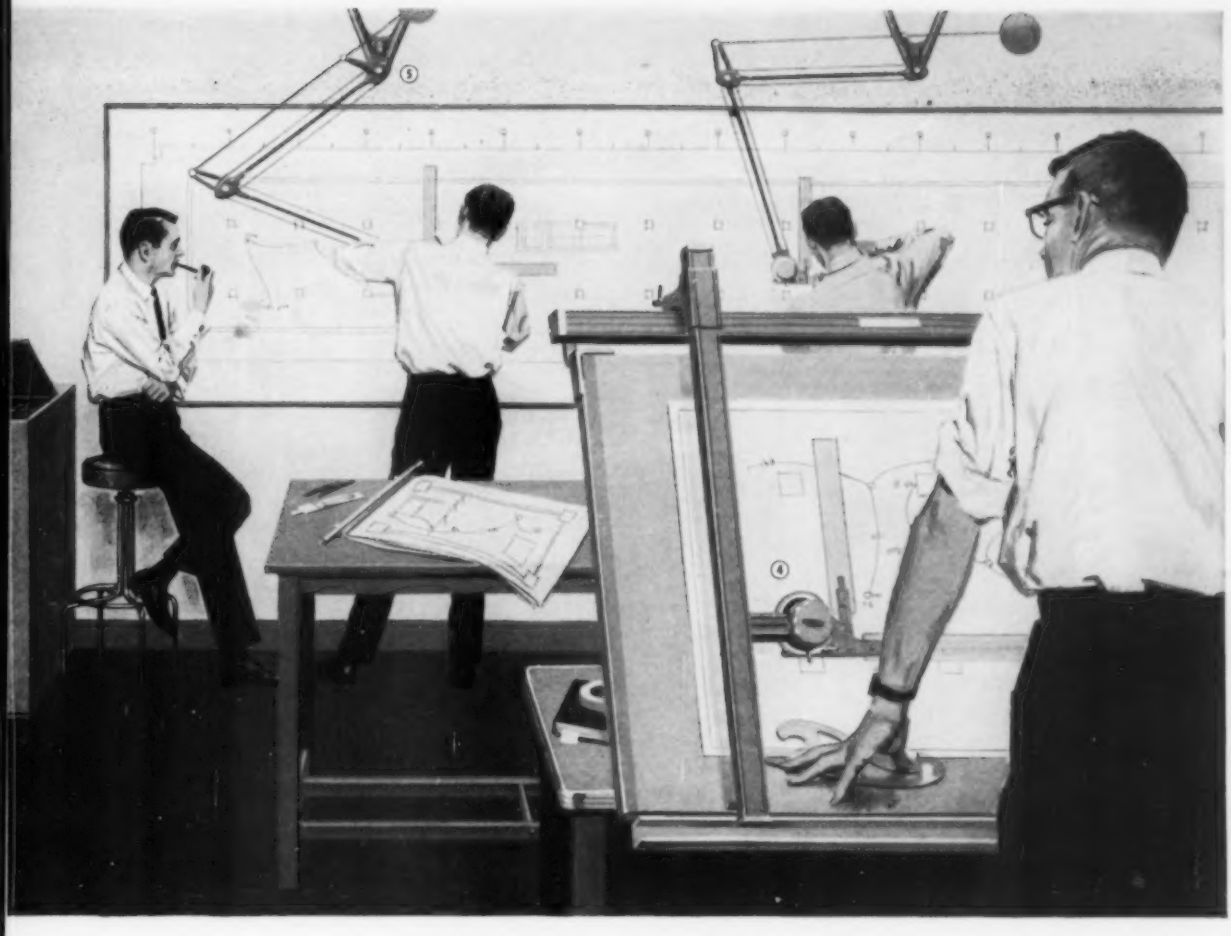
Conventional Arrangement **Auto-Shift Arrangement**

1. Hamilton Auto-Shift Tables. You can put six modern Auto-Shift units where you now have four boards with separate reference desks. Unique design of Auto-Shift lets draftsman work on any part of the board, reach reference table and drawers without leaving his seat. Your draftsmen work faster and better with far less fatigue.

2. Hamilton "L" Contour Tables. The unique "L" shape of this combination board and desk unit provides new reference convenience, new personalized working space, new smartness of surroundings for modern draftsmen and engineers. They work faster, better, and with more pride in their work and surroundings.

3. Hamilton UnitSystem Files. You file drawings and records in units especially designed for them by size and frequency of use. Drawings are faster to file and find. UnitSystem's interlocking feature lets you combine exactly the units you need in higher stacks to save space and to expand filing efficiently and economically.

BRUNING



modernize to speed drafting up to 40% with

drafting machines

Over conventional equipment, modern Bruning drafters speed drafting up to 40% on most jobs . . . up to 50% on some structural drawings. They are far faster and easier to operate than any other drafting machine on the market.

4. All-New Neoglide Drafters. A complete departure from conventional drafting machine design, Bruning's new Neoglide drafters give the draftsman complete maneuverability on any board **at any angle.** Reinforced U-beam construction offers amazing rigidity, strength, and accuracy. Yet resistance-free movement of the counterweight and vertical beam provide free-and-easy "floating" action. No cables or belts to break, stretch, or sag. Touch-control protractor head gives automatic, pin-point angle selection at a touch of the control button.

5. Bruning Track Drafters. Here is the modern, space-saving way to turn out large drawings, faster and more accurately. Unsurpassed anywhere, Bruning track drafters offer automatic indexing, double veniers, and fast scale changes. Models available to provide vertical coverage up to 84" and unlimited horizontal coverage.

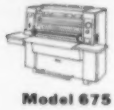
The Bruning Man Gives you the Help you Need When you Need It. He's Located in Principal Cities of U. S. and Canada.

BRUNING

modernize to speed reproduction, eliminate upkeep with

reproduction machines

There's a Modern Bruning Copyflex Machine to Meet Every Need and Budget.



Model 675

Model 35

Model 250

Model 300

Copytron Microfilm Printer

Model 42

1. New Copyflex 675. Years ahead of any reproduction machine, Bruning's Model 675 offers a host of new time-and-work-saving advantages. These include a four-way tracing tray that adjusts to stack or permit fast removal of tracings . . . a feed band system that eliminates curling of tracings . . . enclosed easy-to-load feed rods for roll stock . . . unique system of vacuum ports in the feedboard that hold large sheets and roll stock in position . . . a split-shade lamp control that enables simultaneous insertion of different materials . . . and an electrically controlled push-button machine height adjustment. It offers a mechanical speed of up to 75 f. p. m. and a fast-printing 7,500 watt lamp variable to 5,000 watts, takes sheets and roll stock up to 42" wide.

2. Modern Copyflex 300. This unique, low-cost table top model offers a full 30-inch printing width, gives you professional prints in seconds. By supplementing your main reproduction center with strategically located 300's, you add new dimensions in convenience and economy to your department.

Copyflex machines are odorless, require no venting or plumbing. 8½ x 11" prints cost 1¼¢ each for materials.

BRUNING *Copyflex*® Low-Cost Diazo Reproduction at Its Best!

Call the Bruning Man. His experience and knowledge can save you time and money.

modernize to slash time of re-working drawings up to 90% with

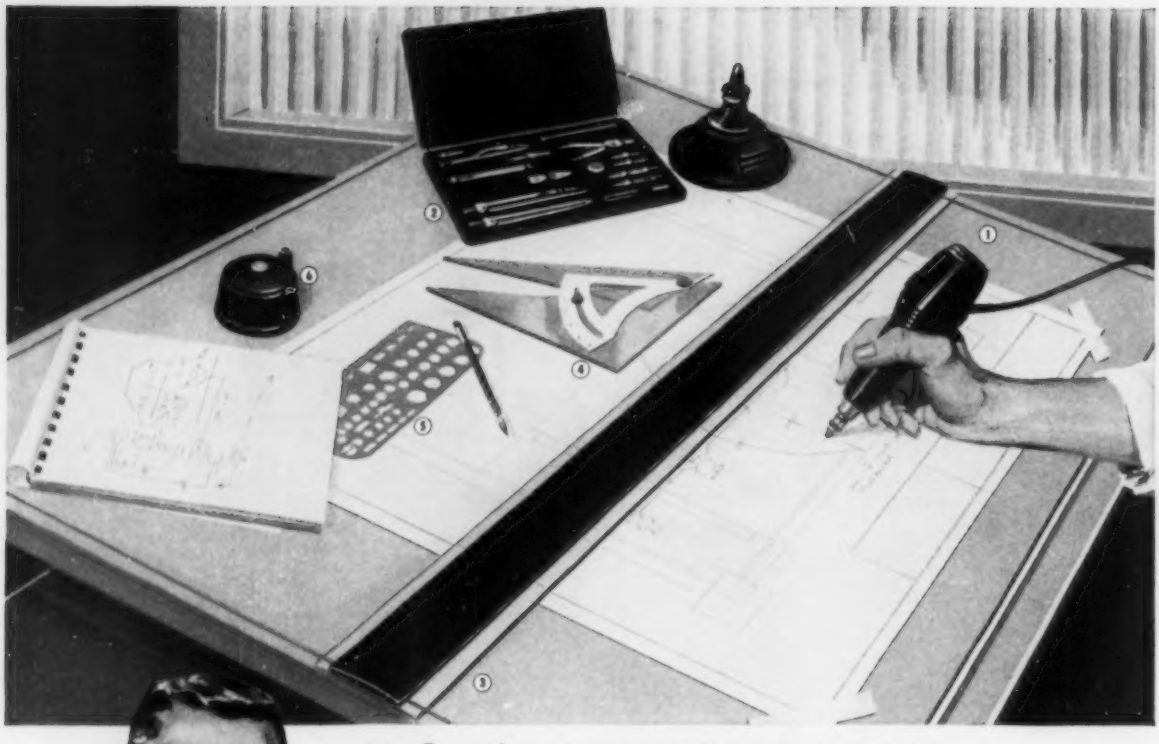
intermediates

3. For design changes or re-working old drawings, modern Bruning intermediates can save up to 90% of the tracing usually required. The draftsman has a Copyflex intermediate (reproducible print) made of the original drawing. Unwanted portions can either be masked out in the printing operation or eradicated on the intermediate itself. New lines then can be added to the intermediate without the tedious, time-taking work of tracing those sections which do not require alteration.

Bruning versatile intermediates are also widely used to speed and simplify print distribution. Sent to distant points, intermediates can be used again and again to make needed prints or to incorporate changes without waiting for new prints from headquarters.

Bruning's complete line of intermediates include paper, matte film, clear film, and cloth.

BRUNING



modernize to speed and simplify draftsmen's work with

drafting aids

1. Bruning Electric Eraser. Minutes add up to hours of time and work saved, over manual erasing, with Bruning's newly improved electric eraser. It's the original hollow-shaft eraser, more widely used than any other. It features 7" erasers, finger-tip "on-off" switch.

2. Stainless-Supreme Drawing Instruments. You'll be time and money ahead with higher precision, durability, and beauty offered only by instruments made entirely of non-tarnishing stainless steel. 5 times harder than brass or German silver. Specially hardened, swivel-type ruling pen points are fast and easy to clean.

3. Bi-Liner Parallel Straightedge. Over conventional T-squares, these moderately priced straightedges more than pay the price difference in faster, more accurate drafting. Features include: warp-proof blade, ball bearing blade pulleys, full length duraluminum tunnel, board-top mounting attachments. Bruning's complete line includes special model with retractile rollers.

4. Adjustable Triangle. This modern precision tool combines the functions of protractor and universal triangle to enable draftsmen to draw all angles faster, easier, and more accurately. Will not discolor or become brittle. Range of sizes.

5. Bolts and Nuts Template. Bruning's wide variety of modern templates enable faster, neater, more uniform execution of symbols and shapes for every type of drawing. Precision-cut from wear-resistant plastics to assure accuracy and durability.

6. Tru-Point Lead Pointer. Here is the fast, convenient, pleasant way of obtaining clean, ideal draftsman's points. Only one hand need be used to rotate pencil and pointer top around stationary base. Graphite dust is trapped inside. Abrasive liners are replaceable.

Call the Bruning Man. **He's backed by a company with over 60 years' experience as manufacturer, researcher, and supplier.**

BRUNING

Charles Bruning Company, Inc.
1800 Central Road, Mount Prospect, Ill.
In Canada: 105 Church Street, Ontario 1

CIRCLE NO. 27 READER SERVICE CARD→

LINDE's NEW PLASMARC TORCH SERVICE

Brings Industry Production Parts From Refractory Metals

No other method of fabricating refractory metals can match this. . . . The high melting points of tungsten, tantalum, and molybdenum are no longer a problem. For LINDE's new *PLASMARC* Torch, working in the temperature range between 15,000 and 30,000 degrees K., can coat parts or form shapes of virtually any size or complexity. It's an entirely new way to make such articles as rocket nozzles, crucibles, components for electronic and X-ray use, and parts for atomic energy equipment!

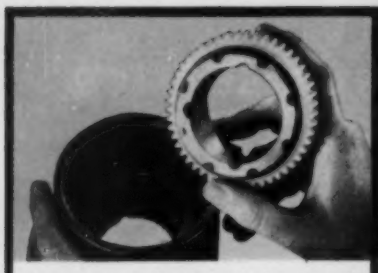
The quality of these pieces is uniformly high. Tolerances can be held to .002 in. or better. The metal loses none of its purity and superior density is achieved.

With the *PLASMARC* Torch, LINDE is equipped to supply you with parts made of, or coated with, refractory metals; or made of a variety of metals combined with non-metals or reinforced plastics. LINDE will also provide a wind-tunnel materials testing service based on this device. For information on this extension of LINDE's well-known Flame-Plating service, write Dept. AW-13, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. In Canada: Linde Company, Division of Union Carbide Canada Limited.

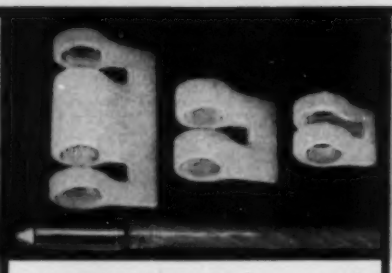
The *PLASMARC* Torch employs a non-transferred electric arc to generate such high temperatures that powder or wire fed into the chamber is literally melted. Inert gases flowing continuously carry the metal particles in a plastic state and deposit them on the workpiece at near-sonic speeds. Jets of CO_2 cool the particles instantly to form heat- and erosion-resistant material. Coatings—even on graphite—have an excellent bond. Shapes are built up on machined mandrels, which are then etched away to leave parts such as those shown above.

Linde UNION CARBIDE

"Linde", "Union Carbide" and "Plasmarc" are trade marks of Union Carbide Corporation.

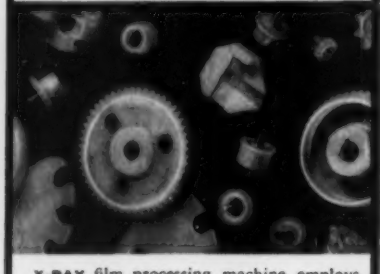


COUPLING employs rugged ring gear of ZYTEL nylon resin. High wear resistance, little or no lubrication are featured. (By Boonton Molding Co., Boonton, N. J., for John Waldron Corp., New Brunswick, N. J.)



BELT-FASTENER PARTS for power and conveyor belts are made of ZYTEL for high tensile strength. Hinge pin of galvanized cable coated with ZYTEL resists wear. (By Flexible Steel Lacing Co., Chicago, Ill.)

ADDING MACHINE uses cams and other components of ZYTEL for smooth, quiet operation. Elimination of waste and machining steps produces cost savings. (By Underwood Corporation, Hartford, Conn.)

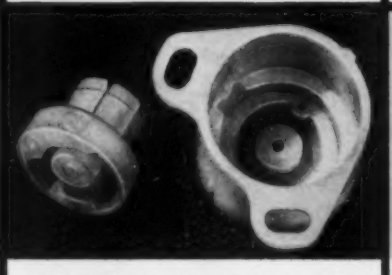


X-RAY film processing machine employs gears and other parts of ZYTEL. Unharmed by photographic chemicals, they lower costs. (By Brook Molding Corp., Norwood, Mass., for Eastman Kodak Co., Rochester, N. Y.)

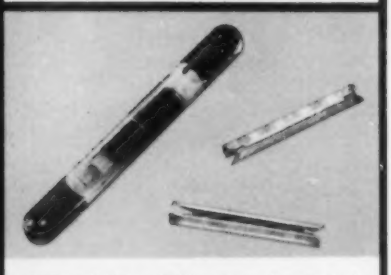
PIPE ADAPTER is tough, won't corrode, costs far less than metal fittings. Made of Du Pont ZYTEL, it is ideal for use with jet pumps and flexible plastic pipe. (Made by Yardley Plastics Co., Columbus, Ohio.)

CONDENSER TUBE PROTECTORS are fracture-proof . . . resist sand blasting, corrosion, solvents. Made of ZYTEL nylon resin, they insure smooth flow. (By Crane Packing Co., Morton Grove, Illinois.)

ELECTRIC SHOE POLISHER has eight lightweight components of ZYTEL. The accurate molded parts provide quiet operation, temperature resistance, low operating friction. (Ronson Corp., Woodbridge, N. J.)



COMBINATION back-up lamp and safety switch for 1959 Ford cars provide economy, heat strength. (By United Plastics, Vassar, Mich., for Courter Products Div., of Model Eng. & Mfg., Inc., Boyne City, Mich.)



REEL of ZYTEL holds suture for surgical ligatures . . . permits sterilization in solvents at 300°F. (By Guild Molders, Inc., Elmsford, N. Y., for Ethicon, Inc., Somerville, N. J., a subsidiary of Johnson & Johnson.)

Latest designs show high strength, wide utility of ZYTEL® nylon resins

So versatile are the properties of ZYTEL nylon resins that they can be used to make basic parts you find in almost any mechanism. ZYTEL is an outstanding gear and bearing material. ZYTEL can be used to make fastening elements, casings, seals, electrical hardware, plumbing parts, richly colored components, intricate shapes with high tolerances. ZYTEL in thin sections is tough, flexible, translucent—capable of use for soft-light lenses. ZYTEL in solid shapes has high impact strength and is resistant to abrasion, heat, chemicals. Best of all, ZYTEL is often the most economical material you can use in your designs.

Many molders have the experience to supply you with parts of ZYTEL in quantity to your exact specifications. For design literature you'll find helpful, write to: E. I. du Pont de Nemours & Co. (Inc.), Advertising Department, Room Z-36-6-22, Nemours Bldg., Wilmington 98, Delaware. *In Canada:* Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

ZYTEL®
NYLON RESINS

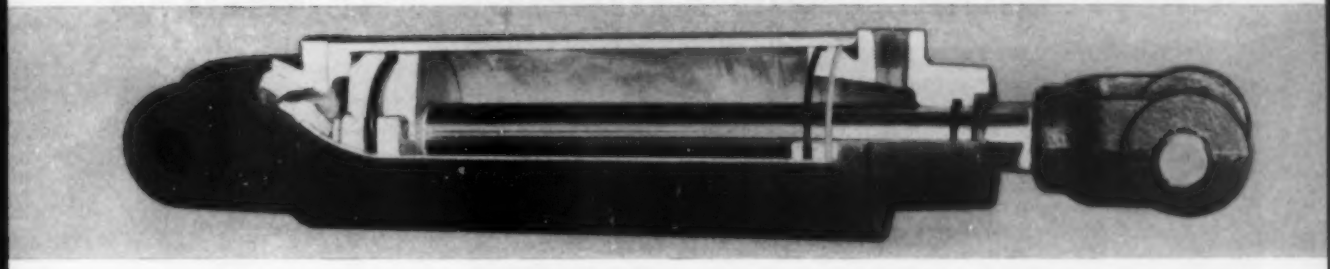
DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING...THROUGH CHEMISTRY

There's a HOLE lot of sense in this use of mechanical tubing

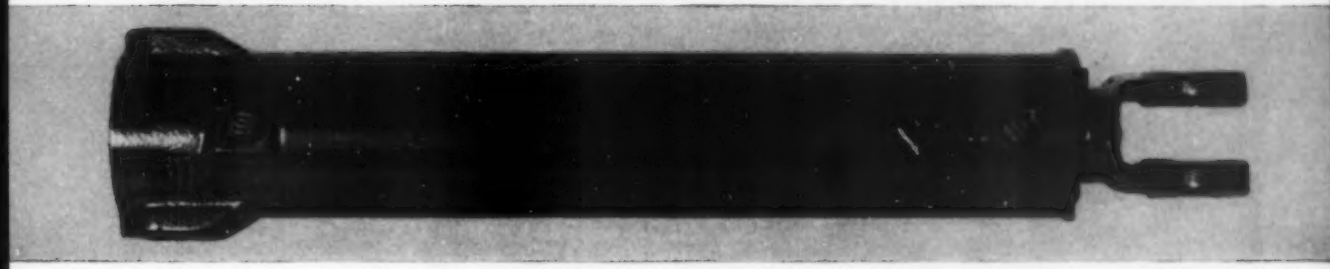
What we're talking about is USS Shelby Seamless Mechanical Tubing. Here's how Industrial Hydraulics Division, Cessna Aircraft Company uses it to boost life, simplify manufacture and lower costs in the hydraulic cylinders they supply to agricultural equipment builders. We quote from their letter to us:

"The cut-away cylinder is a unit we furnish to one of our many customers. This is a 3½" diameter, double-action cylinder used for mounting on pull-behind tools



such as plows, cultivators, and disc harrows. This cylinder uses your Shelby Seamless Mechanical Tubing with the I.D. bored to size and roller burnished to a finish of approximately six to eight RMS. The expected life of this cylinder is in excess of 300,000 cycles, operating at 1,500 psi hydraulic pressure.

"The other cylinder is furnished to another one of our customers, and is a 3¼" I.D. double-action cylinder with a 13" stroke. Used to raise and lower the platform of their self-propelled combine, it is similar to the cut-away cylinder



with respect to finish requirements and material for the barrel. The operating pressure is approximately the same and so is the expected service life of five years, or 300,000 cycles. Generally these cylinders may be serviced for additional use by merely replacing the seals.

"The severe field conditions these cylinders are subjected to are some of the most extreme to which cylinders could be exposed."

In critical mechanical applications like these, and in an almost endless number of fabrications that are essentially tubular in character, Shelby Seamless will ensure improved performance, finer appearance and economical production.

For Shelby Seamless offers more than just a pre-bored hole. It not only combines to an exceptional degree the qualities of strength, uniformity and dimensional accuracy but, in addition, is readily workable and has excellent machining properties. If you want to find out how it can be most effectively applied to your designs, contact your nearby Shelby Distributor.

And remember—USS Shelby Tubing is made by the world's largest and most experienced manufacturer of tubular products.

USS and Shelby are registered trademarks

National Tube Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division • United States Steel Export Company, New York

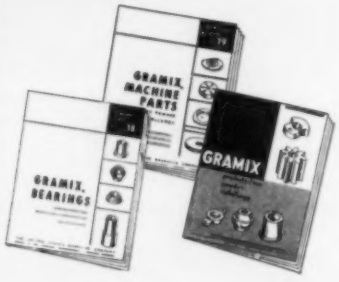
CIRCLE NO. 29 READER SERVICE CARD

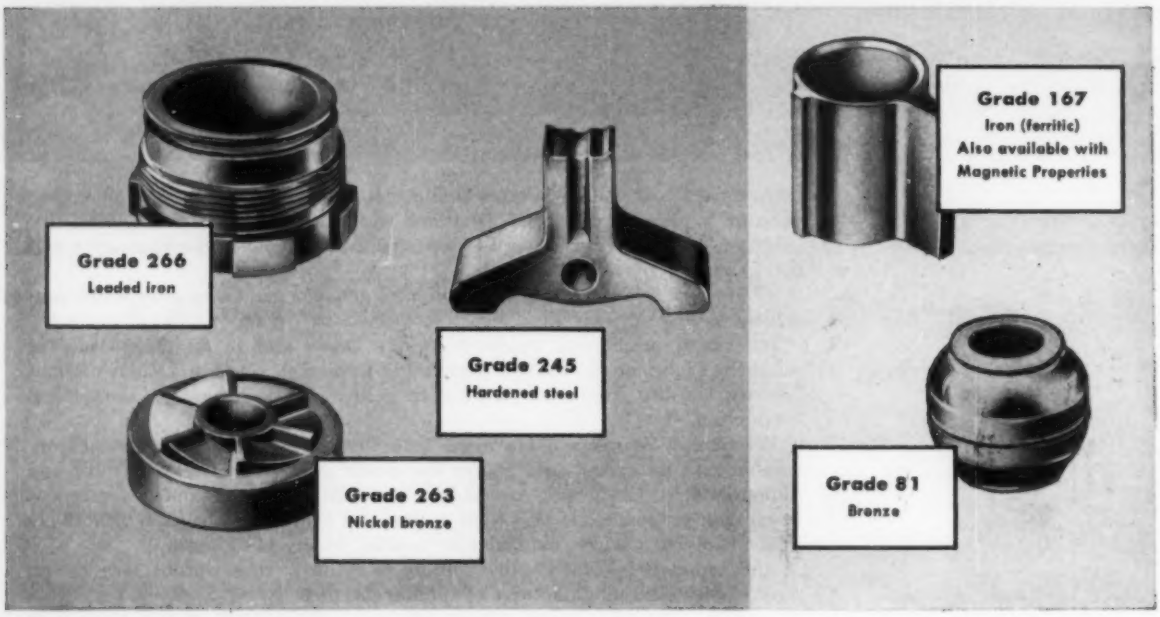
GRAMIX® products made from engineered alloys

To be positive that GRAMIX products of powder metallurgy will function in any given application in the most efficient manner possible, The United States Graphite Company *engineers* the alloy so that it meets exact physical properties required in the application. And, in addition to engineering the alloy to the application, every step in the manufacturing process is rigidly controlled. Correct compacting, controlled sintering procedures and precise finishing operations contribute to the dependable performance of GRAMIX parts.

GRAMIX engineers have the experience, the techniques and the equipment to produce top quality products of powder metallurgy. No matter what type of part you need . . . gear, cam, ratchet or one of unusual shape, no matter what characteristics that part must possess, it will pay you to select GRAMIX . . . and get both "job-engineered" alloys and quality-controlled production to meet each specific operating requirement.

Write today for these helpful engineering manuals. Engineering Bulletin No. 18 covers design and metallurgical requirements and alloy selection of GRAMIX bearings. No. 19 contains facts about GRAMIX Machine Parts and No. 21 contains general information on GRAMIX products from Powder Metallurgy. Get your copies now.



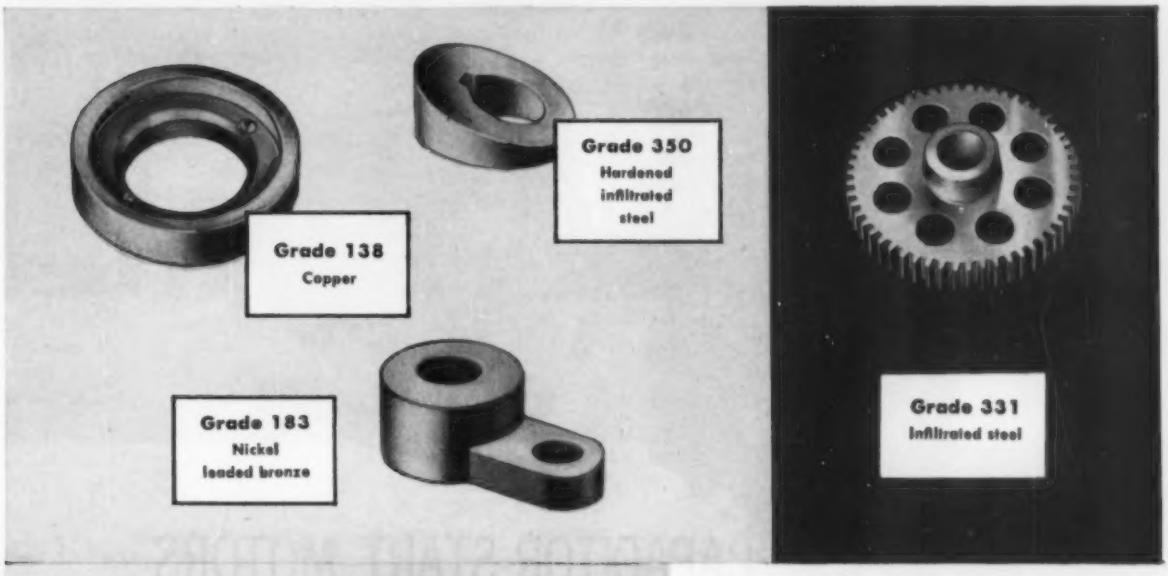


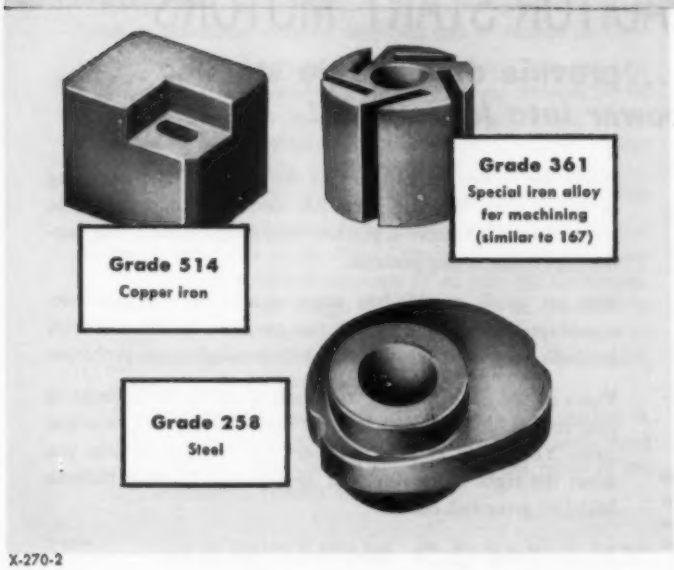
THE UNITED STATES

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

# of powder metallurgy

...meet exacting physical properties





X-270-2

PM MEMBER

GRAPHITE COMPANY

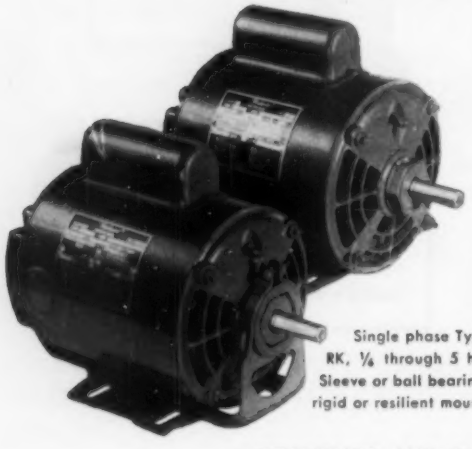
DIVISION OF THE WICKES CORPORATION, SAGINAW 1, MICHIGAN

CIRCLE NO. 31 READER SERVICE CARD 31

Need all-angle operation?

WAGNER CAPACITOR-START MOTORS

operate in ANY position... provide dependable starting...
pack more power into less space!



Single phase Type RK, ¼ through 5 hp. Sleeve or ball bearing. rigid or resilient mount.

Here's the answer for applications that require angle mounting of fhp motors. Wagner Type RK sleeve bearing motors, in fractional ratings, have a positive lubrication system that permits operation in any position.

You get quick, trouble-free starts—thanks to a Wagner designed quick break switch—and you get more horsepower with less bulk, for a better chance to lick those tough space problems.

You can get these motors from leading motor distributors in your community and from Wagner Sales Offices in 32 principal cities. Your Wagner Sales Engineer will be glad to help you select the right motor for your application. Wagner Bulletin MU-217 gives full details.

WM59-6

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

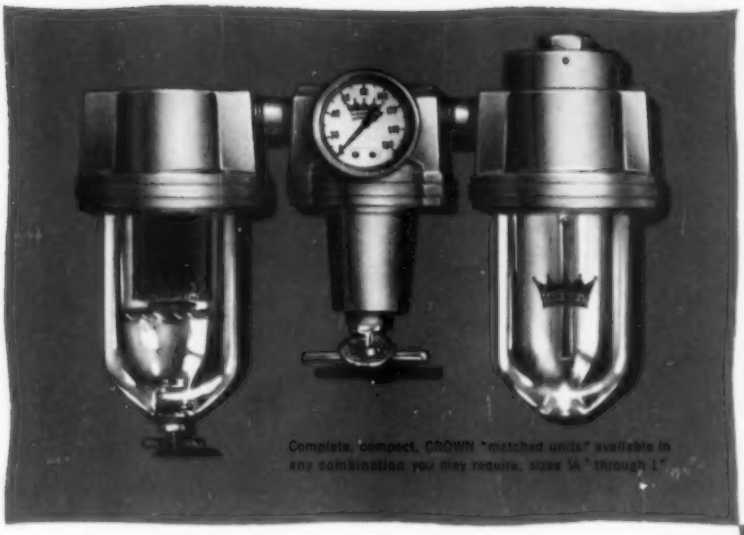
Wagner Electric Corporation

6406 Plymouth Ave., St. Louis 14, Missouri.

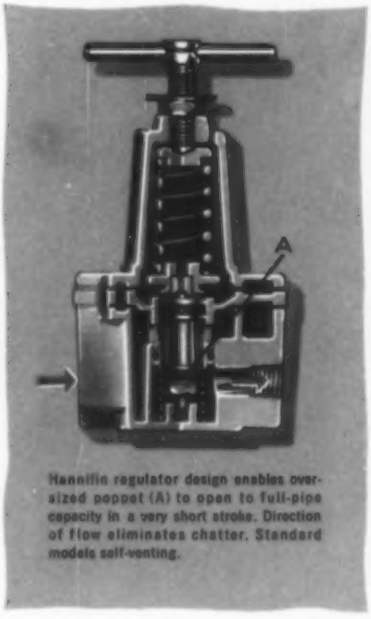
SERVING 2 GREAT GROWTH INDUSTRIES...*ELECTRICAL*...*AUTOMOTIVE*

CIRCLE NO. 33 for FITTINGS, 34 FOR AIR UNITS→

Crown From HANNIFIN air preparation units that don't waste air power



Complete, compact, CROWN "matched units" available in any combination you may require, sizes ¼" through 1".



Hannifin regulator design enables oversized poppet (A) to open to full-pipe capacity in a very short stroke. Direction of flow eliminates chatter. Standard models self-venting.

Hannifin CROWN "Combo" units – filters, regulators and lubricators in any combination – keep compressed air in the "pink of condition" without depriving you of needed air flow.

Crown regulators open fast on demand, close precisely when demand is satisfied, deliver the exact amount of air needed. Their "piston balanced" poppet design, which makes possible a flat, large-area, poppet-type valve with very short stroke, is the reason. The inherent stability of this design – no hunting or chatter – results in multi-million cycle life.

Crown filters have large, reusable filter elements for minimum resistance to air flow. Crown lubricators introduce predetermined amounts of oil into the air stream, automatically. Their design is so responsive to variations in air flow rate that the concealed, tamperproof adjustment is rarely used. This is the easiest lubricator of all to fill, and remote-fill models are available.

Crown units are competitively priced and stocked in principal industrial areas by Hannifin CROWN authorized distributors. For CROWN literature and the name of the distributor nearest you, write:

HANNIFIN COMPANY

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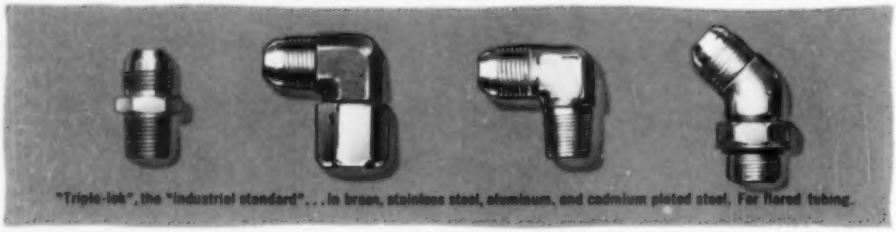
Lubricator cone (A) is factory pre-set for most applications. Valve (B) shuts off air pressure to bowl when fill plug is removed. This patented Hannifin feature permits bowl refill without shutting down air line.

PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS



"Triple-lok", the "industrial standard"... in brass, stainless steel, aluminum, and cadmium plated steel. For flared tubing.

"Ferulok"®, the flareless type with the visible "bite", especially for heavy-wall tubing... in steel and stainless steel.

"Weld-lok" socket-type fittings, steel or stainless steel. Also "Braze-lok", in almost any metal.

"Intru-lok", especially for instrumentation lines. Flareless type in brass and aluminum.

Parker "no-skive" hose and "Hoze-lok" re-usable hose fittings for low, medium and high pressure service.

Only from Parker

such a wide range of fittings...so fast

If it's an industrial fitting, whether for tubing or for hose, Parker has it or can make it, in standard sizes in any metal.

Parker "Triple-lok" for flared tubing . . . Parker "Ferulok"® for heavy-wall tubing . . . Parker "Weld-lok" for high-temperature, high pressure lines. ("Braze-lok", our newest line, does not require an open torch, is for medium temperatures.) "Intru-lok", for copper, aluminum or plastic instrumentation lines, requires no flaring. Parker hose and "Hoze-lok" re-usable hose fittings require no skiving of the hose.

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A DIVISION OF PARKER-HANNIFIN CORPORATION

DEVELOPMENTS TO WATCH...

As a short-term, high-temperature heat barrier (to 5000 F) . . .

. . . the new graphite fibers (*PE—May 4, p 7*), impregnated with phenolic resins, may turn out to be outstanding materials. In preliminary burn-through endurance tests at Continental-Diamond Fibre, Newark, Del, this combination has outperformed—by factors of as great as 10—such combinations as melamine glass and nylon-phenolic (*PE—June 16, '58, p 5*). Furthermore, the graphite-phenolic laminates show little cracking or warping, become red-hot before disintegrating. Much more testing is needed, C-DF engineers emphasize; but these materials certainly rate consideration.

Hard, translucent plastics can be made . . .

. . . by polymerizing a new, low-cost organic material under heat and pressure. The material is dialdehyde starch, developed by US Dept of Agriculture researchers and now going into commercial production at Abbott Laboratories. The material has a good many other possibilities as well, says F.K. Thayer, Abbott vice-president. It might be used as a lubricant or coolant in drilling operations, and shows considerable promise as a low-cost route to improved coatings, binders and adhesives.

A device that anticipates changes in temperature and pressure . . .

. . . is claimed by Australian engineers. Developed at the Commonwealth Scientific and Industrial Research Organization, its first application is to a small furnace, heated by passing an alternating current through a heating coil and controlled within about 2 degrees F by its own on-off controller. The device is said to hold furnace temperature within 0.03°; and is expected to prove useful in controlling hydrogen ion concentration in liquids and variations in pressure, volume, displacement and velocity in other media.

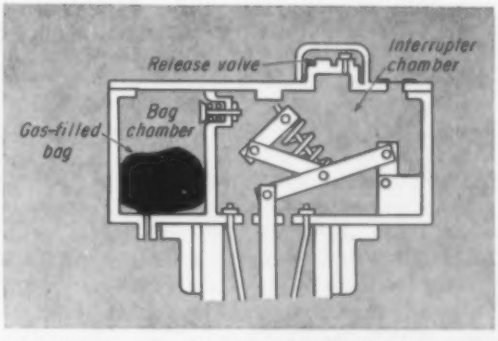
C.K. Coogan of the Div of Chemical Physics describes the device as a two-step controller, having a condenser in circuit with a detector that is sensitive to changing conditions in a given medium and is capable of varying the electrical conditions of the circuit in accordance with those changes.

In its simplest form, the temperature-control circuit comprises a sensing device (a thermocouple), an amplifier, and a solenoid which is arranged to trip a relay on reaching a preset furnace temperature. A condenser, resistors, and a voltage source (battery) are included in the control circuit; and a switch in the furnace circuit is arranged for activation by the relay in the control circuit.

At the lower temperature level (the upper power level), the switches are closed, and the condenser is charged from the battery. But, as the condenser charges at a higher rate than the furnace heats, it anticipates the heating lag by increasing the current in the relay to such an extent that the power is cut off from the heating circuit. Discharge of the condenser (regulated by one of the resistors) also occurs at a rate faster than the rate of cooling of the furnace so that power is switched on again before the temperature drops appreciably below the desired level.

New circuit breaker . . .

. . . has a simple but apparently effective method for holding oil at a constant pressure of about 100 psi, regardless of the contact position of the breaker. Designed by English Electric Co Ltd, it uses an extensible gas-filled bag in place of the usual pump; and, the company says, not only shows improved arc-interrupting properties, but also has the added advantage that the bag acts as a shock absorber and compensates for oil leakage. Aside from the bag and associated features, design of the breaker is of the conventional type. A patent application has been filed, but the unit will not be put into production for several months at least.



To maintain pressure in circuit breaker British engineers use gas-filled bag. Diagram shows upper compartment of typical installation. Release valve is designed to permit escape of gas generated during circuit breaking.

DEVELOPMENTS TO WATCH...

New "hardmetals" can be made . . .

. . . by taking advantage of the fact that the rare-earth elements will form compounds analagous to the carbides, borides, nitrides and silicides of the transition metals (titanium, chromium, vanadium), says Ira Binder of American Electro Metal Div, Firth Sterling Inc. With the increasing availability of the rare earths, it becomes worthwhile to investigate the possibilities of producing new compounds of this type.

At the same time, much remains to be done—and is being done—on the carbides, borides, and nitrides of the transition metals themselves. A recent Russian report notes, for instance, that chromium boride has a melting point close to 3300 F, and titanium boride nearly 5100. In one area, though, the Russians report failure. "Attempts to prepare hard alloys from powders of chromium boride and titanium boride by mixing with iron, cobalt, or nickel powders and pressing and sintering under graphite or alumina in hydrogen were unsuccessful," they say. Resulting products were porous and brittle and had little or no coercivity." Their research, though, is continuing—and ours is too.

New classification system for electrical measuring instruments . . .

. . . is proposed by Business & Defense Services Administration, US Dept of Commerce. This is a "generic" classification, based on structural and operating characteristics, as opposed to present functional systems, which are based on use.

In the BDSA system, instruments are grouped in 6 categories:

1. Optical instruments, such as those for research, navigation, surveying, etc.
2. Electrical instruments, designed to indicate, measure or record electrical quantities, *whether or not they are intended to be applied to electrical quantities.*
3. Gyroscopic instruments, for directional control, stabilization, guidance.
4. Nucleonic instruments, including both those designed for use in atomic-power production and those utilizing radioisotope techniques for industrial purposes not directly connected with atomic energy.
5. Mechanical instruments, applying such principles as differential expansion of vapors in metal, liquid in glass, dissimilar metals, etc.
6. Packaged instruments—"built-up" testing and measuring apparatus consisting of two or more types of instrument mechanisms plus various adaptive and accessory components.

The last category points up the major purpose of the new classification: planning for defense mobilization. As BDSA notes, manufacturers of such equipment generally purchase the mechanisms from other instrument suppliers, and over-all planning must take the interrelationships into account.

The new system is intended as a supplement to, rather than a replacement for, the older system, and forms the basis for a series of surveys now being conducted by BDSA of instrument types and capabilities, and production facilities available for them. First of the studies, on optical instruments, is now available from BDSA Scientific & Photographic Products Div. The others are in preparation.

Seals for minus 400 F are an immediate necessity . . .

. . . and O-rings that can be used on hydraulic, pneumatic and lubricating systems at temperatures above 600 F will soon be in the same class, says Wright Air Development Center's Materials Laboratory.

For temperatures from about —200 F to 400 F, fluorine-containing elastomers look extremely promising. Below that, to about —300 F, synthetic rubber backed by metal may do the job.

In the 400 to 600-F range, the best bet right now seems to be metallized seal; although, as A.A. Lepera of WADC pointed out to a recent SAE meeting, such metal seals "are extremely sensitive to the mating component surface finish, axial deflection, fluid lubricity, vibration, and temperature gradients."

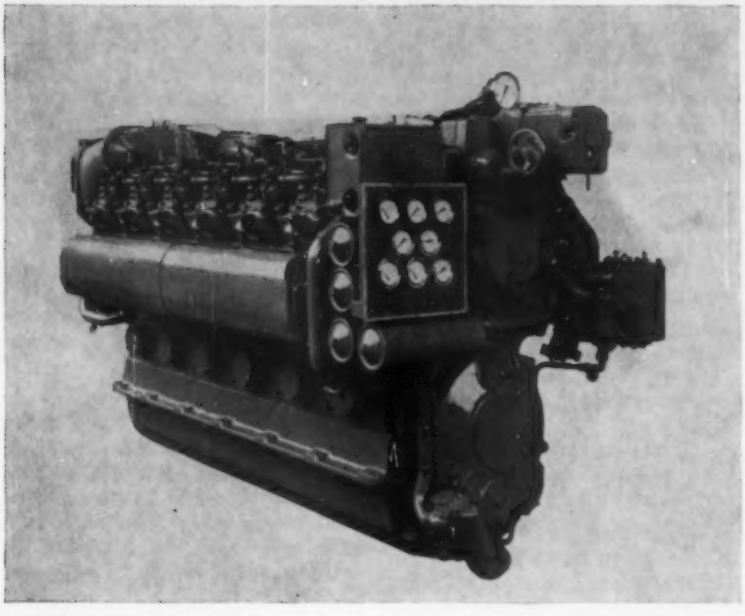
A good many WADC contracts have already been awarded for research at both ends of the scale. Battelle Memorial Institute and Horizons Inc, for instance, have been working on heat-resistant metals for possible service at temperatures to 2000 F. (Preliminary reports on the work of these organizations are available from OTS, Dept of Commerce, Washington 25, D. C. The Battelle report is PB151483, 59 pp, $1.50. The Horizons report is PB151451, 74 pp, $2.)

At the other end of the temperature scale, National Bureau of Standards is working under WADC contract to develop static and dynamic seals for service to minus 452 F.

Most of the big aircraft companies, too, have contracts to develop or test elastomeric, metallic, and metal-ceramic materials.

Reports should be coming from WADC and its contractors regularly from now on.

—ARG



Hydrogen is the fuel . . .

This 12-cyl, 2-stroke diesel developed in W Germany couples directly to a reciprocating compressor. Pipes running vertical to manifolds along each vertical side of the engine carry fuel gas. Note shortness of HT cables carrying ignition current to the spark plugs.

Germans Develop Europe's First Hydrogen-gas Diesel Engine

BONN—Europe's first internal combustion engine using hydrogen gas has been developed by Kloeckner-Humboldt-Deutz AG of Cologne. The engine has same applications as any other conventional stationary diesel engine.

Such engines in the US are located at right angles to the driven compressor, but the K-H-D mechanism operates directly over a flywheel to the given unit. Advantage here is the prime mover and driven unit can be separated quickly and at any time —to allow the engine to be used for other applications, or the driven unit to be powered in an emergency by an electric motor.

By interposing a train of gears between prime mover and driven unit, an engine with higher rating and higher flywheel speed can be used to drive slow-running compressor unit.

At 500 rpm, a 12-cyl V-engine built by the same company develops 1125 hp when running on clean refinery gas containing up to 85% hydrogen. The trunk-type piston engine is water-cooled, utilizes reverse scavenging, and has a mechanically driven booster to feed combustion gas into the cylinders at slight overpressure. Piston stroke is 12⅝ in.; bore, 10 in. Water-cooled gaskets are fitted between cylinder block and heads. Standard engine equipment includes a centrifugal governor and servomotor control system. ■

Next Step: Storable Liquid Propellants

LOS ANGELES—Considerable progress in the development of liquid propellants to power the 1½-million lb thrust engine being developed for space exploration, is reported by Rocketdyne Div of North American Aviation.

The area of progress is in liquid propellants which can be stored in tanks indefinitely without evaporating or corroding the tank. This would indicate that cryogenic materials would not be needed.

Development of the high-energy storable fuel is several years away, but the evolution is traceable. The first generation—hydrazine, unsymmetrical dimethyl hydrazine (UDMH), nitrogen tetroxide, and interhalogen compounds—can take over from the now-standard RP1-LOX mix with only slight modifications. These have reached intermediate and advanced stages of development and their specific impulse values are equal to those of the standard fuels being used.

The next group of storable fuels will have increased specific impulse—perhaps 360-370 sec—and are currently available for applied propulsion research. The final step are fuels that have as their objective a 390 sec specific impulse. These will require extensive chemical-synthesis research, and laboratory development is necessary.

Apparently, the fact that Polaris and Minuteman missiles were designed around solid fuels has not discouraged the proponents of liquid propellants. ■

Undertakes Hi-temp Hydraulic Research

FARMINGDALE, L. I.—Republic Aviation has been assigned the job of developing a hydraulic control system that will withstand heat generated when an aircraft flies 4500 mph. The research will be done under a $354,000 Air Force contract calling for a two-year study of high-temperature hydraulics.

Under this contract, Republic is asked to develop and test components for a power control system capable of operating at all temperatures between 20 and 1000 F. Such a range will be required for aircraft flying at Mach 7 and for space ships re-entering the earth's atmosphere.

Working under earlier Air Force contracts, Republic has already verified the existence of hydraulic fluids that operate between 20 and 1000 F. ■

Tighter Control of Test Equipment Studied by Armed Services

NEW YORK—An increasing pressure is being exerted by ASESA (Armed Services Electro Standards Agency) on independent laboratories and manufacturers, doing work for the government, to obtain certification of their testing equipment.

ASESA is a combined agency of the Army, Navy and Air Force, has primary justification over testing equipment standards used to prove any item on the Qualified Product Listing of the three services. ASESA's function is to set minimum calibration standards for all equipment. It requires that all testing equipment calibration be traced to standards set up by the Bureau of Standards. Up to now, in many cases, only lip service was paid, but ASESA is presently holding up approval of electrical, electronic, hydraulic, mechanical components, if the testing equipment calibration cannot be traced to the Bureau of Standards within the time limit set by its specifications for items on the QPL.

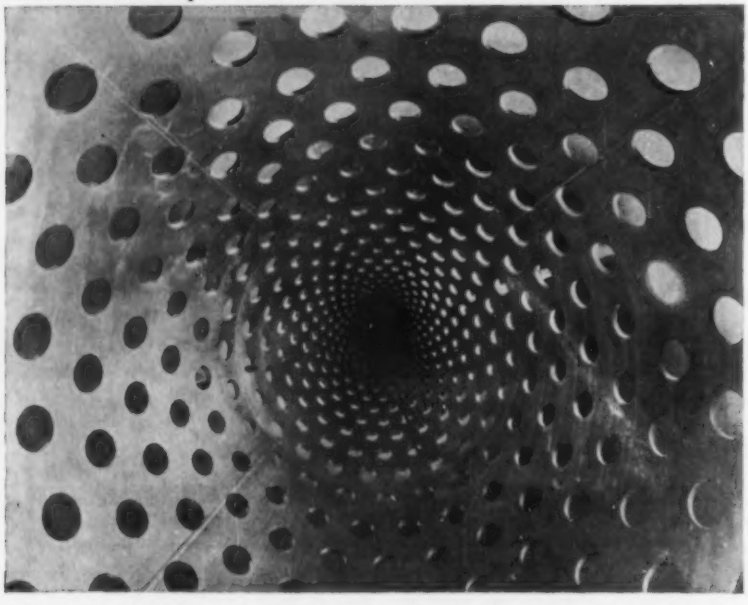
The Air Force and the Navy are reportedly getting into the act. They are making similar checks on equipment used for components not on the QPL, but used by them individually.

The hope is that a better end product will result as now all components will be tested on newly calibrated equipment, and the services and ASESA intend to keep it that way. In fact, Congress has recently increased the Bureau of Standards allotment for standard calibration equipment. This indicates an increase in equipment calibration is foreseen and may be traceable to the recent increase in activity by ASESA.

Richard Hahn, head, engineering dept of US Testing, Hoboken, believes the move is a good one. "From an engineering standpoint better and more uniform products will result with increased assembly reliability, but constant calibration and equipment checking will increase overall costs."

A spokesman at ASESA headquarters, Fort Monmouth, NJ, admitted that the agency's activities have been mounting, particularly where tubes and semi-conductors are concerned. In addition, inplant testing operations now come under ASESA jurisdic- now come under ASESA. ■

Removes Bumpiness in Mach-6 Wind Tunnel



A large volume (40,000 cu ft) of heated, dry air is stored in large tanks at high pressure and suddenly released by a quick-acting valve into the stilling chamber shown here. This chamber damps any pulsations in the air stream, before it enters the test section. Test runs can be varied from 40 sec to over 90 sec, speed range will be from 300 to 3600 mph. Power is supplied by a 7000-hp synchronous motor which drives the centrifugal compressor system to deliver air at 625 psia to the storage vessels at a max rate of 23 lb/sec. Tunnel is being built at McDonnell Aircraft Co, St. Louis.

DOD Handles NASA Security Clearances

WASHINGTON—An agreement between the Dept of Defense and the National Aeronautics & Space Administration makes DOD's Industrial Security Program available to NASA. The agreement eliminates duplication of the Defense Department's program in NASA.

Under terms of the agreement, DOD will issue security clearances to employees of NASA contractors and will inspect their facilities and operations. The arrangement applies equally to contracts administered by a military department for NASA and those administered solely by NASA.

Here's a run-down of DOD-NASA security relations:

- The military service with security responsibility over a contractor facility will provide security services for NASA at the facility.
- If a proposed contractor is not already cleared, DOD will take necessary steps and authorize a military service to handle security matters.
- NASA will adopt existing DOD regulations, but will have a voice in revisions.
- A voting NASA deputy will sit on DOD boards examining clearance for NASA contracts. ■

Cost-cutting Features Highlight Design

DETROIT — Interchangeability of Studebaker-Packard Lark components include: bumpers interchangeable front and rear; one roof stamping to fit two- and four-door sedans as well as the hardtop; simple, one-piece sheetmetal in front with detachable fenders; combined license plate and trunk light; and tail-lights interchangeable left and right. ■

Beryllium Hurdles Tests As Structural Material

CONCORD, MASS.—Beryllium has moved a step closer to application as a structural material for aircraft in places where simple shapes are required. Nuclear Metals Inc, a metallurgical research firm here, has developed a process for making beryllium sheet with optimum grain orientation. Result is sheet that overcomes the brittleness which has heretofore limited use of this light metal.

The company has also successfully assembled sections of the sheet into a box beam similar in design to those found in aircraft. Nuclear Metals developed the process, then designed and constructed the box beam under subcontract to the Martin Co. Dynamic and static evaluation tests on the beam were performed in the Martin Co laboratories.

Aircraft engineers have long been anxious to develop this material: It combines high elastic modulus with a density only slightly heavier than magnesium (*PE—April 6, p 25*); it absorbs 2½ times more heat than competing structural materials under a given rise in temperature.

A very important contribution of the Martin Co to the present development of structural beryllium was the soundly practical view taken by their engineers, according to sources at Nuclear Metals. These engineers have been thinking in terms of fitting design to the material rather than material to the design.

Under the contract that resulted from this approach, Nuclear Metals managed to improve the bi-axial ductility of beryllium by developing a forging process that assures optimum grain orientation. For beryllium this means that the basal planes have just the right amount of preferredness with respect to the plane of the sheet, and the prism planes are randomly oriented at right angles to the plane of the sheet. The present process is ideally suited to making sheet that can subsequently be fabricated into complex forms such as I-beams, H-beams and box beams.

Tests at Martin for box beams produced by Nuclear Metals have shown results that in cases are superior to Martin's minimum requirements. Ultimate tensile strength has ranged between 65,000 and 70,000 psi with yield point of 40,000 psi. Compression strength has run 49,000 psi. And a bulge test exceeded standard requirements by 2 or 3 times according to Martin sources.

In the Nuclear Metals process, powdered beryllium is cold compacted and sealed in a thin-wall iron can. This beryllium is then heated to 1800 deg in an argon atmosphere for a half hour, and finally pressed into a pancake shaped sheet in a standard forging press.

The original cylinder measures 7 in. high and 7 in. dia. The final sheet is 20 in. dia and ¼ in. thick. Martin sources see no limit to possible sheet sizes. The present dimensions were chosen because they are best suited to aircraft requirements and are the lowest cost.

In fabricating the sheet into box beams, engineers at Nuclear Metals used standard carbide drills for making holes. They took special precautions to keep the material from cracking. Sheets are riveted together. Welding is not suitable for this beryllium, according to the company.

To date the program has been experimental. Martin hopes the results will induce firms to undertake commercial production of the material in the near future.

BARE EXTRUSIONS

Nuclear Metals is also working on a bare extrusion process that may eventually be suitable for producing complex shapes. This extrusion process starts with conventional bare round billets of sintered beryllium rather than canned beryllium. The company is also working on processes for rolling or otherwise working beryllium.

Toxicity—a property of beryllium that along with brittleness is a major drawback—has been successfully handled at Nuclear Metals. (Through inhaling beryllium, some people contact a lung disease known as beryllitis.) The material must be stored in closed containers while in powder form, according to sources at Nuclear Metals, and areas where people are working with the powder must be well ventilated. In fabricated form beryllium is harmless unless fumes or dust are released during machining. ■

US Firm Imports Japanese Auto

The Fuji Precision Machinery Co and Cameron Motor of Sacramento, Calif, have contracted to bring Fuji's Skyline car to the American market. Maximum speed of the import is 78 mph with a GA-30 engine, 84 mph with a GB engine. Fuel economy is 31 mi/gal at average speed of 30 mph. Skyline's price will be $2200 with the GA engine and $2300 with the GB engine.

US to Bolster Japanese Industry—Some Day

TOKYO—Japan's lack of airtight security laws and the fact that the Sidewinder air-to-air missile is already in production in the US are keeping the Defense Agency from awarding the Japanese a contract. However, said the Agency, there is no reason why it would not be possible for Japan to

turn out Sidewinder missiles at some time in the future.

Meanwhile, industrial sources in Japan say local avionics manufacturers are getting ready for the production of guided missiles anyway—in anticipation of $10 million in orders to be given by the US Defense Agency in the next few years. ■

Rupture Data for Malleable

LAFAYETTE, IND.—New data from Purdue Univ guides design for malleable iron up to 1200 F. From this research project sponsored by the Malleable Founders Society, preliminary tensile data for malleable irons show little loss in strength up to 700 F. At 800 F or above, both tensile and rupture strength drop. Rupture strengths for 10 and 1000 hr are given below for ASTM 6003 pearlitic malleable and high- and low-carbon ferritic malleable irons.

Type	Temp F	Stress, 1000 psi	
		10 hr	1000 hr
Pearlitic	800	45	39
Pearlitic	1000	20	11
Ferritic low C	800	32	25
Ferritic high C	800	24	16
Ferritic low & high C	1000	11	7
Ferritic low & high C	1200	5.5	3.2

Another New Company Merchandising Patents

NEW YORK—A new company that will help business firms sell or license patents and processes developed by individual research projects is being formed. The company will be called the National Patent Development Corp and will have offices here and in Washington.

A similar venture by North American Aviation, Navan Products, Inc, has been operating on the West Coast. (PE—Mar 9 '57, p 37) ■

Japanese Seek Data on R&D

TOKYO—The government here is taking an increased interest in the volume of research carried out by Japanese industry. The government's Science and Technology Agency recently made a survey of industrial R & D. It is somewhat similar to surveys the National Science Foundation pioneered in the US.

The survey covered nearly 1000 industrial firms that were believed to be engaged in research work. Results from 703 companies showed that industry spent roughly $87 million on R & D in 1957. Specialists believe the total rose to $100 million in 1958.

Research is well distributed throughout industry as the accompanying chart indicates. Especially heavy expenditures were made in chemicals—30% of the total—and electrical machinery industries—23% of the total. By way of contrast, chemical firms in the US account for about 7% of all research and electrical firms about 20%. Heaviest research expenditures in the US—about 35% of the total—occur in the aircraft industry. Transportation equipment industries in Japan account for only about 8%.

The Japanese report says that the scale of R & D in the US and Britain dwarfs that of Japan. US research is about 70 times greater than Japanese; British about 5 times. They attribute the differences to the generally larger size of industries in those countries and to the fact that industry does a considerable amount of work for the government. In Japan, commercial firms do very little government research work.

R & D is Widespread in Japanese Industry

	Research Spending (in million $)	Total Spending, %
Chemical	$26.1	30
Elec Machinery	20.0	23
Trans Equip	7.2	8
Iron & Steel	7.1	8
Textiles	3.6	4
Machinery	3.4	4
Ceramics & Quarrying	3.0	3
Foodstuffs	2.6	3
Nonferrous Metals	2.4	3
Pulp & Paper	1.7	2
Measuring Instruments	1.6	2
Miscellaneous	3.4	4
Nonmanufacturing	5.2	6
	$87.3	100

Canadair Expands Design Facilities to Get US Missile Work

MONTREAL—Canadair Ltd, a subsidiary here of General Dynamics, has set up a new missiles and systems division as part of its plan to become a major sub-contractor for missile work in the US. Robert D. Richmond, formerly chief engineer of special weapons for Canadair, is vice-president in charge of the new division.

The action, following only eight months after termination of Canadair's Sparrow missile program, indicates a strong willingness by GD to continue substantial investments in terms of scientific manpower and equipment in order to handle new missile work of the most advanced nature.

The new division is a technical task force that has been kept compact, self-contained and flexible for the express purpose of being strongly competitive with US subcontract firms—and thereby gain a share of contracts which are made available to Canadian companies under the production-sharing arrangements which exist between the two countries.

With the new organization, Canadair can investigate potential contracts and future requirements, and submit quickly and accurately engineering proposals, schedules and cost analyses—elements of paramount importance in this highly competitive field.

The speedy tendering of bids by an organization of this kind is essential since this enables it to establish its own priorities, schedules, and overhead costs without directly relating its work to other activities of the division or company.

Apart from subcontract work, Cana-

dair representatives claim for their organization the "complete missile engineering capability to undertake design and development work on original missile weapon systems."

In the meantime, the United Kingdom Treasury and Supply Delegation in the US has awarded the Avion Div of ACF Industries a $193,000 contract to produce radar beacons for its long-range missile program. According to a company spokesman, this is the third contract in six months placed with Avion by the United Kingdom for the radar units. ■

Foreign Licensing Calls for Much Preparation

NEW YORK—Extensive preparation and a basic understanding of foreign company problems are essential to a successful licensing arrangement between American corporations and companies abroad, Fred Mears, director of international services for the Bettinger Corp, told the American Management Association here recently.

Tracing the development of his own company's growth, Mears described licensing and "know-how" agreements made to produce Bettinger's ceramic-on-metal products in countries that include Canada, Germany, Belgium, France, South Africa, and the Philippines.

One of the biggest challenges posed, Mears said, is the language barrier—communicating technical information in the face of wide differences in technical vocabulary between two languages calls for extensive preparation. ■

ASME NOTES:

On Diesel Design, Fuel Cells, Engineer Budgets

ST. LOUIS—The cost to a manufacturer of repairing or replacing components of his products that may be defective has spiraled in recent years, according to A R Adler of General Electric's Aircraft Nuclear Propulsion Dept. His remarks were contained in an engineering paper delivered before the semi-annual meeting of the American Society of Mechanical Engineers here last week.

"There once was a time . . . when it was possible for someone endowed with a few wrenches, screwdrivers, bailing wire . . . to maintain . . . mechanical devices which he and his neighbor possessed. In those days warranties were quite limited . . . Now, much equipment is built so that corrective action in the field is almost impossible, and it is necessary to replace an engine unit or component.

"The complexity of many of the goods manufactured for home and industry is rapidly changing this situation. An increasing amount of this equipment is built so that corrective action in the field is almost impossible." Mr. Adler concluded by outlining methods that may be used by engineers to estimate the amount of money spent.

Devices which generate electric power directly from heat, without the use of complicated boilers and spinning generators, were described at the ASME gathering. One, called a fuel cell, would burn conventional fuels to produce a flow of usable current. The other, called a thermionic converter, might use heat from a nuclear reactor or from the rays of the sun.

Special lightweight thermionic converters might power the radios and instruments of an earth satellite, reported V C Wilson, of the General Electric Research Laboratory, who explained that in their simplest form, thermionic converters consist of a vacuum tube in which one piece of wire is heated enough to make it give off electrons while a colder piece of wire collects the electrons and feeds them to an outside circuit.

Fuel cells, according to H A Liebhafsky and David L. Douglas, may make compact energy sources for everything from cars to space ships.

Trend in diesel engines is toward use of heavier residual fuels because jets are making the light grades scarce and expensive, according to P G Burman, consutling mechanical engineer with American Bosch Arma Corp in Springfield, Mass. New techniques permit diesels to use fuels rated as low as Number 6. Residual fuels, he explained to the ASME, are all that is left of the crude oil after the lighter and more profitable products have been removed at the refinery. ■

COMING EVENTS

JUNE

24-26 . . . . Instrument Society of America, Second National Symposium of the Nuclear Industry Div., Idaho Falls, Idaho.

29-July 1 . . . . Institute of Radio Engineers, 3rd National Convention on Military Electronics, Sheraton-Park Hotel, Washington, D. C.

AUGUST

4-5 . . . . American Astronautical Society, 2nd Annual Western Regional Meeting, Ambassador Hotel, Los Angeles.

4-6 . . . . Society of Photographic Instrumentation Engineers, Annual Convention and Exhiborama, Ambassador Hotel, Los Angeles, Calif.

18-21 . . . . Western Electronic Show and Convention, Cow Palace, San Francisco, Calif.

23-25 . . . . American Society for Metals, Eastern New York Conference on fracture of Engineering Materials, Rensselaer Polytechnic Institute, Troy.

SEPTEMBER

10-11 . . . . Society of the Plastics Industry, Midwest Section Conference, French Lick Sheraton Hotel, French Lick, Indiana.

21-22 . . . . Steel Founders' Society of America, 57th Fall Meeting, The Homestead, Hot Springs, Va.

20-25 . . . . Instrument Society of America, 14th Annual Conference and Exhibit, Chicago Amphitheater and downtown hotels, Chicago, Ill.

23-25 . . . . Office Equipment Manufacturers Institute, Business Equipment Exposition, National Guard Armory, Washington, D. C.

23-25 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, 4th Annual Special Technical Conference on Non-linear Magnetics and Magnetic Amplifiers, Shoreham Hotel, Washington, D. C.

28-Oct 1 . . . . American Welding Society, Fall Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

CORRECTION

Through a typographical error in the June 8 issue, the prices of three plastics in the table on p 77 were quoted in cents/lb. They should read cents/cu in.—Editor

Reader To Editor...

Inverted Steel Mill

To the Editor:

Could you possibly have turned J&L's Sendzimir mill upside down? (cover, May 25) I haven't built many steel mills, but I have heard of the Law of Gravity. If springs are needed to hold the bottom rolls down, why aren't more springs necessary to hold the top rolls up?

—David M Murphy
Mason City, Iowa

• We sure did. We must also apologize to Mr. Sendzimir for misspelling his name. Our thanks to Messrs Bramhall, Polakowski and Romer for also spotting the inverted cover. Here's how it should have looked.—Ed. ▼

Dialects in Engineering

To the Editor:

Your editorial on page 41 of the March 30 issue of Product Engineering, entitled "Dialects in Engineering," is very pertinent to the times.

Although we are not at this time in a position to take an active part in a cooperative effort like that in Delaware Valley, we will appreciate being kept informed on their progress and accomplishments.

—J L Stackhouse Jr
Mgr, eng admin
DeWalt Div, AMF

Russian Translations

To the Editor:

Being a permanent reader of PE, I have read in some issues of your magazine about a shortage of translators from the Russian. I am a designer with good knowledge of the languages concerned and can translate technical literature in the field of mechanical engineering, hydraulics and electroplating. My translation capacity is 40,000 words monthly.

May I ask respectfully for your help to get in touch with people who would be interested? I can receive the originals and return them with translations by air mail.

—Oscar Mast, AMIED
20/24 Hagana Street
Kiriat Bialik, Haifa Bay
Israel

Time to Change Time

To the Editor:

I wish to add my congratulations to the Acting Secretary of Commerce Lewis Strauss for his action in pushing the change from the English measurement system to the metric system (PE—May 18, p 11). However, while we are changing measurement systems, how about changing the present measurement of time to some system as convenient to work with as the metric system. This would eliminate the messy conversion of seconds to minutes to hours, etc.

—D R Bross
Canoga Park, Calif

• *Also see PE—June 8, p 90.* Any suggestions?—Ed.

Likes Industrial Design Coverage

To the Editor:

I would like to compliment you and your magazine staff for the excellent series of articles involving design in a broader sense than the technical aspects alone. Bringing to the attention of your readers the fact that aesthetics are a valuable contribution to a product regardless of the use to which it is put is a valuable contribution to the product development process. As an industrial designer (also an engineer), I feel that this assist is particularly valuable coming from a technical publication. I sincerely hope that your readers find this worthwhile and interesting and that you plan to continue this program as a regular part of your publication.

—D L McFarland, *president-ASID;*
Manager-Industrial Design Operation
Housewares and Radio Receiver Div
General Electric Co

• We will continue to carry this kind of material in future issues because it is important for the design engineer to understand that there is much more to the product development process than mechanical detail alone.–EJT.

Man's Tougher Than You Think

To the Editor:

Referring to your editorial, "Edge of the Unknown", (May 4, p 27) you state that the human body can, for short periods, move unaided at 15 mph or deliver ½ hp, also that it can withstand a 2-mile altitude range. Surely a man, when running in a 100-yd race will move at 24 mph, when running upstairs will generate 0.9 hp, and when flying in a plane, has full control over his faculties at 15,000 ft.

There is a tribe of South American Indians near the Andes, who live in an extinct volcano at 21,000 ft, and the British Expedition to Everest in 1953 climbed to 28,000 ft before using oxygen.

As Product Engineering is usually very factual and interesting reading material, I feel that these errors should be brought to light.

—B J Ruffell
Ford Motor Co Ltd
Dagenham, England

• Reader Ruffell is right, of course—he took maxima, while I chose averages, allowing a bit (subjectively), for increasing avoirdupois and advancing age. I am reminded of the story of the lecturer who said that thought was the fastest human reaction—sometimes faster than light. One of his auditors, after the lecture, remarked that the lecturer had defeated his own point on two counts: (1) he had in several instances spoken before he thought; (2) the light, if there had been some in his remarks, was long gone when he finished.—EJT

Hi-temp Metal-to-Metal Seal

To the Editor:

One of the inventions in your column, "Why Don't They R & D" (Apr 20, p 52) mentioned a zero-leak coupling for nuclear power plant piping. A coupling that exceeds the requirements mentioned in your article has been developed by our company. Our pipe joint joins dissimilar metals with a metal-to-metal seal for temperatures from —300 F to 2000 F and pressures up to 20,000 psi, with a leakage rate of 1×10^{-6} cc/sec on a mass spectrometer. This joint is now being used in nuclear power installations.

—A H Cassidy
Marman Div, Aeroquip Corp

Spring out of Proportion

To the Editor:

The dynamic system that is illustrated on page 65 of the April 27 issue is rather unconvincing as the deflection is out of all proportion to the actual size of the spring shown. These small details may not be of much importance but surely they can be irritating and even confusing at certain times.

—K N Chaurasia
Glasgow, Scotland

US Boat Bridge

To the Editor:

In the May 11 issue, "Interesting to Note" (p 7), you carried an article about a bridge for boats. You probably are not aware of this same type of construction in this country. A good example of one is near Yardley, Penna. The original was built about 1860, of wood. That is now replaced with a steel one, and, of course, is no longer used except for small craft pleasure boating. I believe the company that built the canal was the Lackawanna or the Delaware and Hudson Railroad.

—John W Holter, *President*
The Holter Co
, Bridgeport, Penna

CIRCLE NO. 43 READER SERVICE CARD→

first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers • No. 63

ANNOUNCING A NEW SILICONE GEL

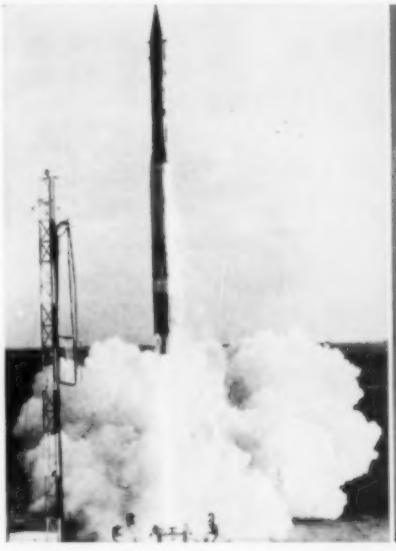
A new silicone, that's supplied in fluid state, can readily be converted to a stable gel. Recently made available by Dow Corning, this new silicone holds much promise as a new engineering material. Typical properties include transparency, heat stability, resiliency, high moisture resistance.

A versatile new silicone, Dow Corning Dielectric Gel has unlimited possibilities for sealing, filling and potting; as a suspension medium; for vibration damping; for impregnating capacitors, magnetic amplifiers and other devices; and a variety of other design possibilities . . . you name the application, and weigh the advantages that this new silicone can provide.

Developed primarily as a potting material for electronic parts, Dielectric Gel has these unique characteristics. Supplied as a water-white fluid with the viscosity of molasses, it pours easily and flows readily around the most intricate parts. It sets up in 48 hours, or can be gelled in 30 minutes with moderate heating. The result is a transparent, resilient gel with good dielectric strength, high moisture resistance

and excellent thermal stability. Subsequent heating will not liquify the gel. Like other silicone fluids and compounds, Dielectric Gel retains its physical and dielectric properties over a wide operating temperature span.

Used as a dielectric for filling and potting electrical and electronic assemblies, the gel's unusual transparency allows visual checks of a potted circuitry, (Cont. pg. 2)



TAMING "HOT" MISSILE FUEL

One of the challenges facing designers of missile launching equipment is the development of practical ways to handle "hot" fuels and oxidizers such as 90% concentrated hydrogen peroxide. Here's how Silastic®, the Dow Corning silicone rubber, helped solve this problem:

In its concentrated form, hydrogen peroxide is one of the powerful chemicals developed for oxidation or direct propulsion of rockets and missiles. This chemical reacts so violently in contact with organic materials, however, that finding a suitable means of transferring it from aluminum or ceramic storage tanks to missiles on their launching pads posed a stubborn problem. The concentrated peroxide decomposed so rapidly in contact with conventional flexible hose that it generated explosive forces equal to ⅔ an equivalent amount of nitroglycerine.

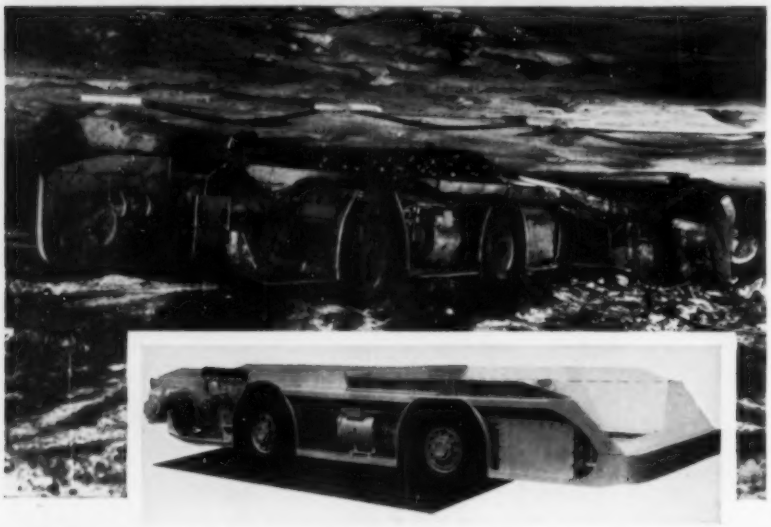
Hewitt-Robins, Stamford, Conn., solved the problem with hose made of Silastic, the Dow Corning silicone rubber. Silastic makes it possible to transfer and handle the peroxide fuel without contamination or change of concentration. Hewitt-Robins combines the desirable properties of Dacron fabric and Silastic by selectively fabricating these two materials in a highly flexible hose having a burst strength exceeding 600 pounds. The hose is fabricated in diameters up to 6 inches and in lengths up to 50 feet. Easy to handle, reel, and store, this hose is currently used by the Navy, Army, and Air Force, for handling and transferring concentrated peroxide liquid propellants.

The section of hose shown is 6" ID heavy duty suction and discharge type believed to be the largest silicone rubber hose built, capable of 600 psi burst and more than 20,000 pounds tension.

Silastic offers other desirable properties that make it practical under adverse conditions. One example, Silastic can withstand long term exposure to temperatures as high as 500 F and remains serviceable at temperatures as low as —130 F. **No. 643**

TAPES THAT STICK

Dow Corning silicone pressure sensitive adhesives make tapes stick to anything. They achieve a strong, long lasting grip and maintain the desirable properties that characterize silicones — serviceability over a wide range of temperatures; resistance to oxidation, weathering, corrosive chemicals; water repellency; and retention of good dielectric properties. For complete design data on the unique insulating, bonding and sealing abilities of tapes made with Dow Corning silicone adhesives, and their applications, circle ..... **No. 644**



REDUCE DOWNTIME IN THE PITS

Silicone insulated drive motors keep production moving even under the adverse operating conditions found in coal mines. Proof is the exceptional reliability of silicone insulated electrical mining machinery produced by Goodman Manufacturing Co., Chicago.

Best way to design for reduced downtime, Goodman engineers have found, is to insulate electrical drive motors for their mining equipment with Dow Corning Silicones. Used in coal, gypsum, potash, and other mining operations, Goodman equipment is powered with silicone insulated motors to assure the extra overload capacity needed for long life . . . dependable, easy, safe operation.

Take their new four-wheel drive "584" shuttle car, for example. It's powered by 440 volt, 3 phase, 60-cycle current through a cable reel to 20-hp traction motors located between the wheels on each side. Each of the two motors drives a front and rear wheel through drive shafts, a gear reducer and differential.

At high speed, the motors operate at 1750 rpm and are rated 75 C rise at full load . . . at low speed, motor rpm is 875, temperature rise, 120 C. Silicone insulation permits efficient operation of these permissible type a-c traction motors at overloads that push motor temperatures above rated Centigrade rise. Variations in car speed are obtained without electrically controlled clutches and torque converters.

Designed for continuous, uninterrupted service, these shuttle cars must have adequate speed to effect quick trip transfer of loads from the working area to the transportation system. Drive motors "must be built for rugged service" say Goodman engineers in specifying Dow Corning silicone insulation. *No. 645*

DIELECTRIC GEL *(Continued)*

and permits test probes to be accurately directed to connections for instrument checks. Self-healing, the gel automatically seals punctures when probes are withdrawn.

Dielectric Gel is highly resilient. It exerts no stress on delicate parts either during or after cure, and will not damage sensitive parts as a result of fluctuating temperatures — a problem with rigid potting materials. What's more, the gel provides potted parts with excellent protection against shock and vibration. *No. 646*

new literature and technical data on silicones

Design Material Selector—Arranged as a materials selection guide, an 8-page reprint from Electronic Design lists solutions to each of more than a dozen problems confronting designers of electrical equipment. This reprint is a guide to data on specific silicone products that help electronic systems meet a wide range of service conditions and assure longer, more reliable performance demanded of today's equipment. *No. 647*

Specifying Problem—Economical, strong, lightweight, dielectric materials made from silicone molding compounds may be the answer to your specifying problems. Parts and structural components molded from Dow Corning silicone molding compounds give excellent service despite such environmental conditions as moisture, heat, corrosion and fungus. The typical properties and performances offered by silicone molding compounds are compiled in a brochure. *No. 648*

Voids Avoided — Self-adhering Guide Line triangular tape made from Silastic, the Dow Corning silicone rubber, is ideal for insulating form wound coils of motors and generators. Because it bonds into a homogeneous insulation wall, flexible Guide Line tape can eliminate voids without the use of filling materials. Also good for insulating connections and terminals, triangular tape's shape permits easy and economical processing, assures uniform insulation wall thickness. A recent reprint from Insulation magazine gives full details. *No. 649*

Design Versatility — Lightweight, strong, inert, and easy to fabricate, silicone-glass laminates are used in the design and manufacture of a variety of consumer and industrial products. Applications, tables of physical and dielectric properties, illustrations of various parts, and sources of silicone-glass laminate parts are included in a 4-page brochure. *No. 650*

A Lubricant Manual presents some of the more important aspects of the selection of the most suitable oils or greases for instrument ball bearings. Portions are devoted to military specifications applicable to miniature instrument bearing lubricating, and special attention is given to lubricants with special properties. An invaluable reference work for your design files. *No. 651*

Dow Corning Corporation, Dept. 8618, Midland, Michigan

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New!

20 pages of helpful information about J-M Chempac Teflon products . . .

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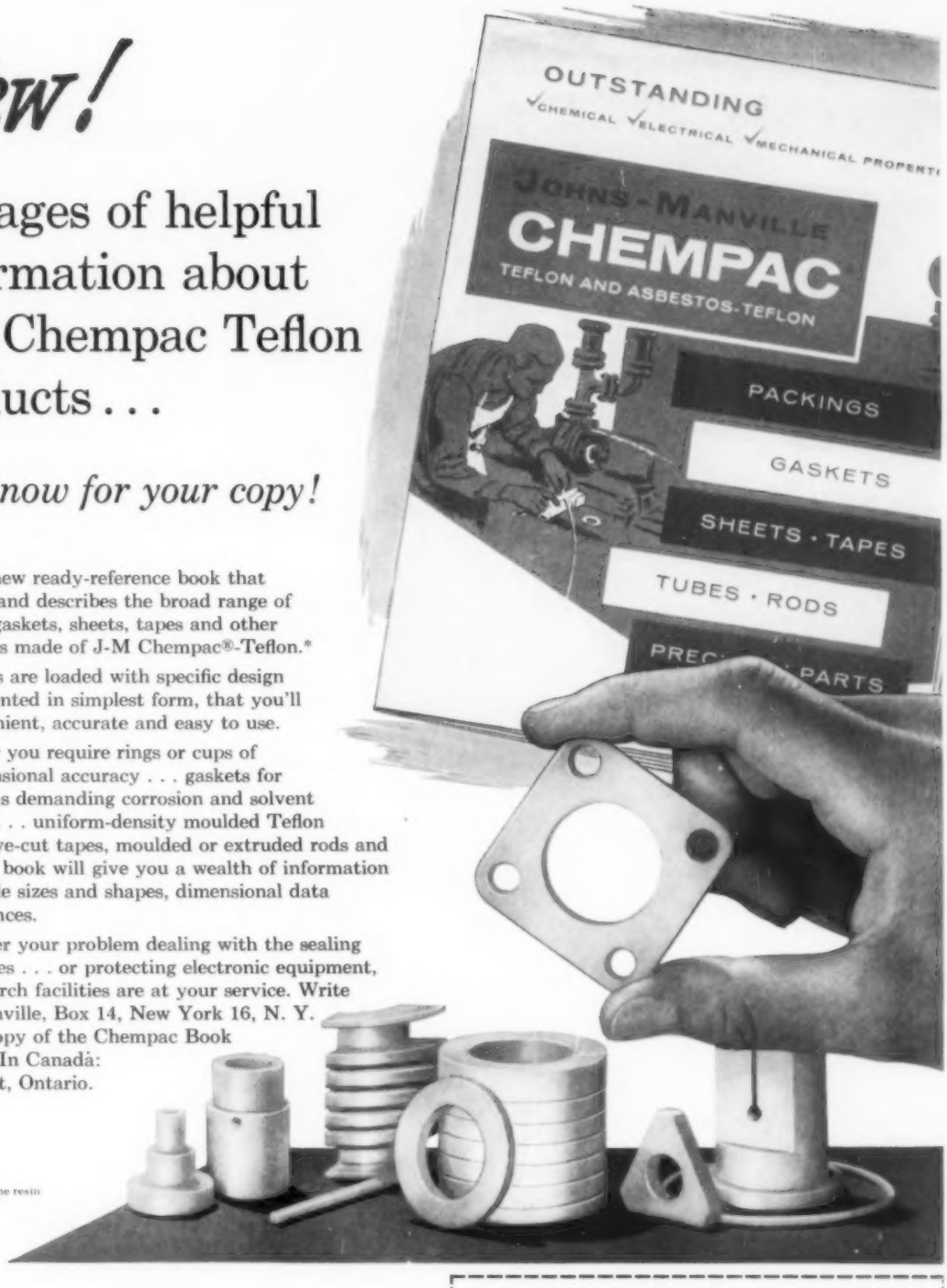

Here's a new ready-reference book that illustrates and describes the broad range of packings, gaskets, sheets, tapes and other components made of J-M Chempac®-Teflon.*

Its pages are loaded with specific design data, presented in simplest form, that you'll find convenient, accurate and easy to use.

Whether you require rings or cups of high dimensional accuracy . . . gaskets for applications demanding corrosion and solvent resistance . . . uniform-density moulded Teflon sheets, skive-cut tapes, moulded or extruded rods and tubes, this book will give you a wealth of information on available sizes and shapes, dimensional data and tolerances.

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*TM for DuPont Tetrafluorethylene resin

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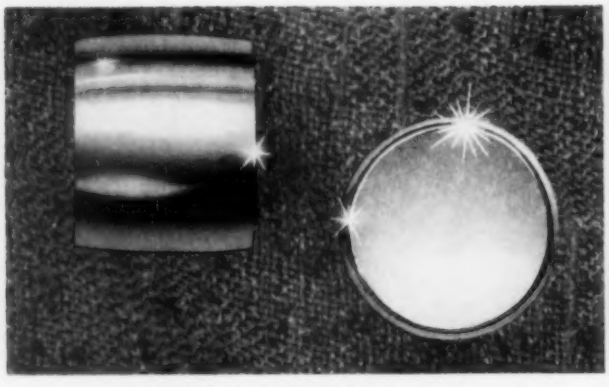
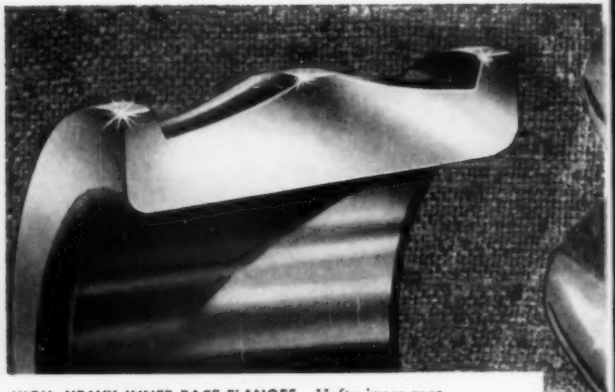
News! The best features of modern bearing design combined

Spherical

SELF-ALIGNING ROLLER BEARINGS BY LINK-BELT



BIG, HIGHEST-CAPACITY ROLLERS. Each bearing has a maximum number of rollers—as large as possible, yet all components are in optimum balance. Precision-ground to extreme accuracy, these convex rollers offer maximum economy for all applications.



HIGH, HEAVY INNER RACE FLANGES. Hefty inner race has sturdy shoulders which offer convenient hold for assembly and removal of bearing. They end problems of cutting away shaft or applying pressure at outer race . . . avoid any need to skimp on shaft shoulders.

BIG, mirror-smooth convex rollers *plus* heavy, broad-shouldered inner race *plus* centrifugally-cast bronze, precision-machined retainer! Only from Link-Belt do you get ALL that is best in bearing design.

Individually, these elements represent major improvements on accepted design concepts. Collectively, they constitute the most efficient spherical roller bearings available . . . promise unequalled economies, whatever the application. Men who know bearings will readily recognize new contributions to capacity, endurance and ease of maintenance.

For the good of your equipment, take time for a feature-by-feature comparison with any bearings you're now using. Your Link-Belt office will gladly explain the many performance advantages evolved with this new design. It can furnish full data on industry's most complete line of ball and roller bearings . . . pillow blocks and flanged, flanged cartridge, cartridge and take-up blocks.

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PRECISION-MACHINED, CENTRIFUGALLY-CAST BRONZE RETAINERS offer many times more support and ability to withstand high stress. They are not stampings—they space rollers accurately under extreme speeds and loads. Independent cage action for each row of rollers assures maximum bearing efficiency.

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Total Motor Burnout Protection*...

NO OTHER PROTECTOR PROVIDES 6-WAY COMPLETE PROTECTION

Most conventional protectors used today may protect motors against up to four overheat conditions. KLIXON Type T Protectors safeguard motors from all six conditions:

1. Running overload with or without high ambient or ventilation blocked.
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3. Locked rotor caused by low voltage where decreased torque is insufficient to start load.
4. Locked rotor with main winding only in circuit resulting from open circuit start switch or open circuit in reversing switch.
5. Locked rotor with start winding only in circuit, such as that resulting from an open main winding circuit or open circuit in reversing switch.
6. Running with both start and main windings in the circuit resulting from start switch failure in closed position or low voltage which prevents reaching switchover speed.

Only New KLIXON Type T Protectors Completely Safeguard Your Motors

With KLIXON Type T Protectors in induction motors you are assured of *complete protection against all possible conditions that cause motor overheating and burnouts.* Here is how you benefit by using KLIXON-protected motors . . . motors operate at safe maximum output without premature failure . . . motor repairs, replacements and service are reduced . . . and most important, customer satisfaction and good will are retained. *Be 100% safe* . . . protect your motor-driven equipment completely against motor burnouts . . . specify on your purchase orders — "These motors to have KLIXON Type T Protectors."

Over 150,000,000 motors are protected against overheating and burning out with KLIXON PROTECTORS.

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Spencer Products: Klixon® Inherent Overheat Motor Protectors
Motor Starting Relays • Thermostats • Precision Switches • Circuit Breakers

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D'Arazien

Alcoa puts the metal where you want it

In less time than it takes you to say "Impact," even the longest of these impacts can be fully formed and flawlessly finished—longitudinal hole, closed end and all—from a single slug of Alcoa® Alloy 6061-T6. Impacts, produced to tolerances as close as plus or minus 0.0005 in. without *any* further processing . . . with smooth, ultra-hard, corrosion-resistant finish 125 microinches both inside and out.

The above pictorially represents the growth of the finished part which, as produced, is approximately 16 in. long: a missile hydraulic component made by Alcoa for Vickers, Incorporated. It represents savings that are scarcely short of fabulous. Estimate for yourself what it would cost to produce such a form by laborious machining from bar stock—the only practical alternative. Include all the labor of rough-cutting, precision machining and final finishing—*and* the costly waste of metal.

Does this suggest impressive savings? Undoubtedly! But not necessarily more impressive than those you can gain if you consider Alcoa Impacts whenever you need: any closed-end or tubular component, of whatever shape, with such additions as external or internal fins, ribs or bosses . . . and with the highest strength attainable in any given alloy. Separate finishing operations are always reduced to virtually zero, and tooling-up costs are surprisingly low. The more you know about impacts, the more uses—and savings—you'll find in your own production. For eye-opening data, write to: Aluminum Company of America, 918 Alcoa Building, Pittsburgh 19, Pennsylvania.

Alcoa puts the metal where you want it—in castings, forgings, extrusions, screw-machine parts and impacts.

ALCOA ALUMINUM

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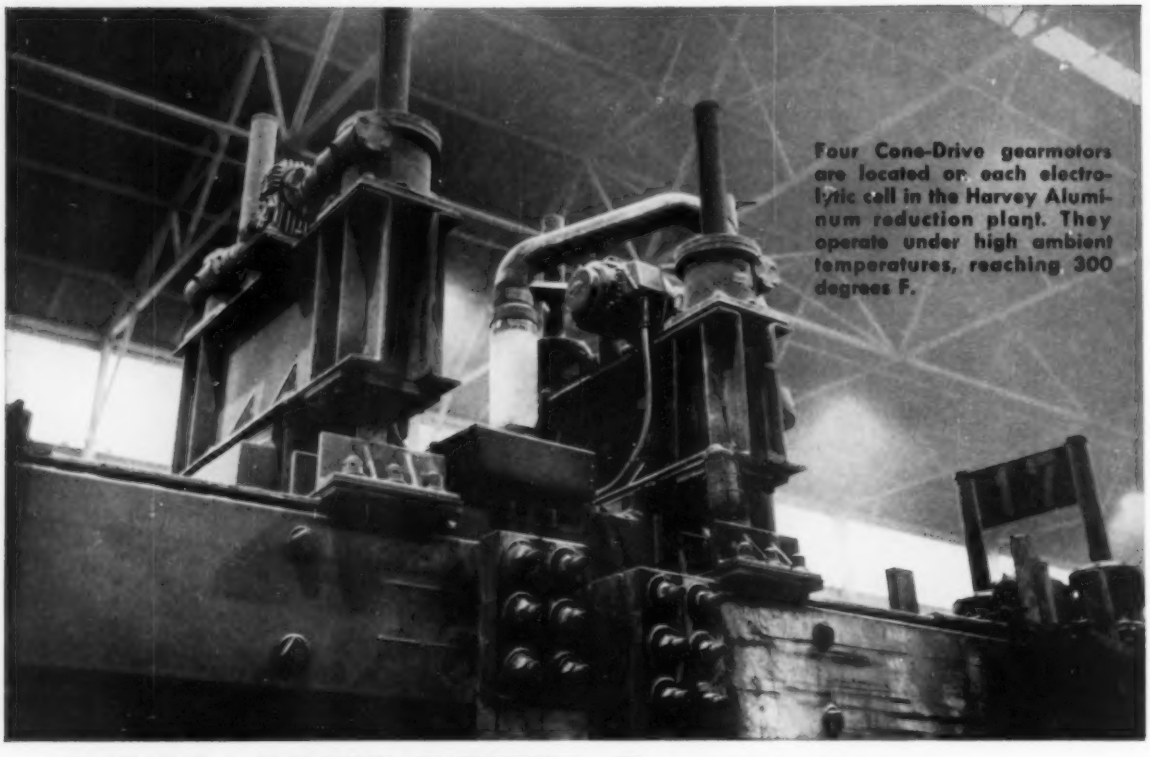
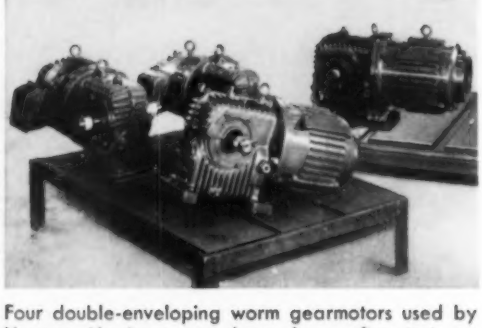


Four Cone-Drive gearmotors are located on each electrolytic cell in the Harvey Aluminum reduction plant. They operate under high ambient temperatures, reaching 300 degrees F.

1,000 CONE-DRIVE Gearmotors to produce 100,000,000 lbs per year at Harvey Aluminum



Four double-enveloping worm gearmotors used by Harvey Aluminum are shown here after test run in Cone-Drive plant. They were palletized in groups of four for shipment to Oregon smelter.

From its modern reduction plant at The Dalles, Oregon, Harvey ships primary aluminum in pig, ingot and billet forms all over America. The smelter includes the latest and most efficient equipment and operating techniques. Reflecting this modern equipment are 1,000 Cone-Drive double-enveloping worm gearmotors, used to control the height of anodes and casings in relation to the molten aluminum bath in each of the electric furnaces. Annual capacity is more than 100-million pounds.

The gearmotors are operated under high ambient temperatures that reach 300° F. This was an important consideration in Harvey's selection of Cone-Drive gearmotors. In addition, the ability to withstand the full force of stalled driving motors and constant reversing operations figured in Cone-Drive gearing's selection.

Cone-Drive double-enveloping worm gearmotors are available in a wide variety of styles and sizes. Models include standard shaft or hollow shaft with worm over or under or gearshaft vertical. Capacities range from ¼ to 40 HP and reductions from 3.3:1 to 240:1. Ask for Catalog No. 58 for complete specifications.

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

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DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

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LOWER-COST DRIVES

...one of 3 advantages you can choose from when you specify premium V-belts reinforced with

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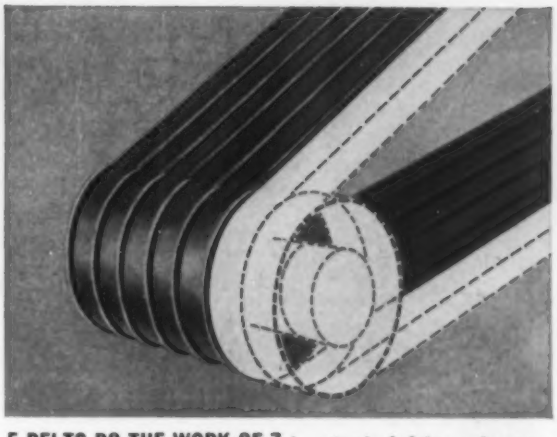
DRIVE COST GOES DOWN when your design calls for premium belts made with DACRON. Fewer, stronger belts mean you can use smaller, less-costly sheaves—so total cost is lower.



5 BELTS DO THE WORK OF 7 in a typical drive using premium V-belts reinforced with DACRON. Great strength of DACRON allows freedom of design with fewer or smaller belts and sheaves . . . creates a compact, efficient drive.

UP TO 40% MORE HORSEPOWER with premium V-belts of DACRON makes them ideal for heavy-duty drives. And DACRON is *stable*—has 1/20th the moisture regain of rayon cord used in belts. This simplifies matching problems.

EXTRA STRENGTH in premium V-belts reinforced with Du Pont DACRON* polyester fiber offers solutions to major drive-design problems. Once installed, these belts continue to improve efficiency and economy. V-belts reinforced with DACRON are stable and resist stretch . . . there's less need for maintenance, less time spent in matching.

FREE BOOKLET tells the complete story of V-belts reinforced with DACRON. For your copy, fill out and mail the coupon below. Du Pont makes the DACRON fiber used by belt manufacturers in producing their finest-quality V-belts.

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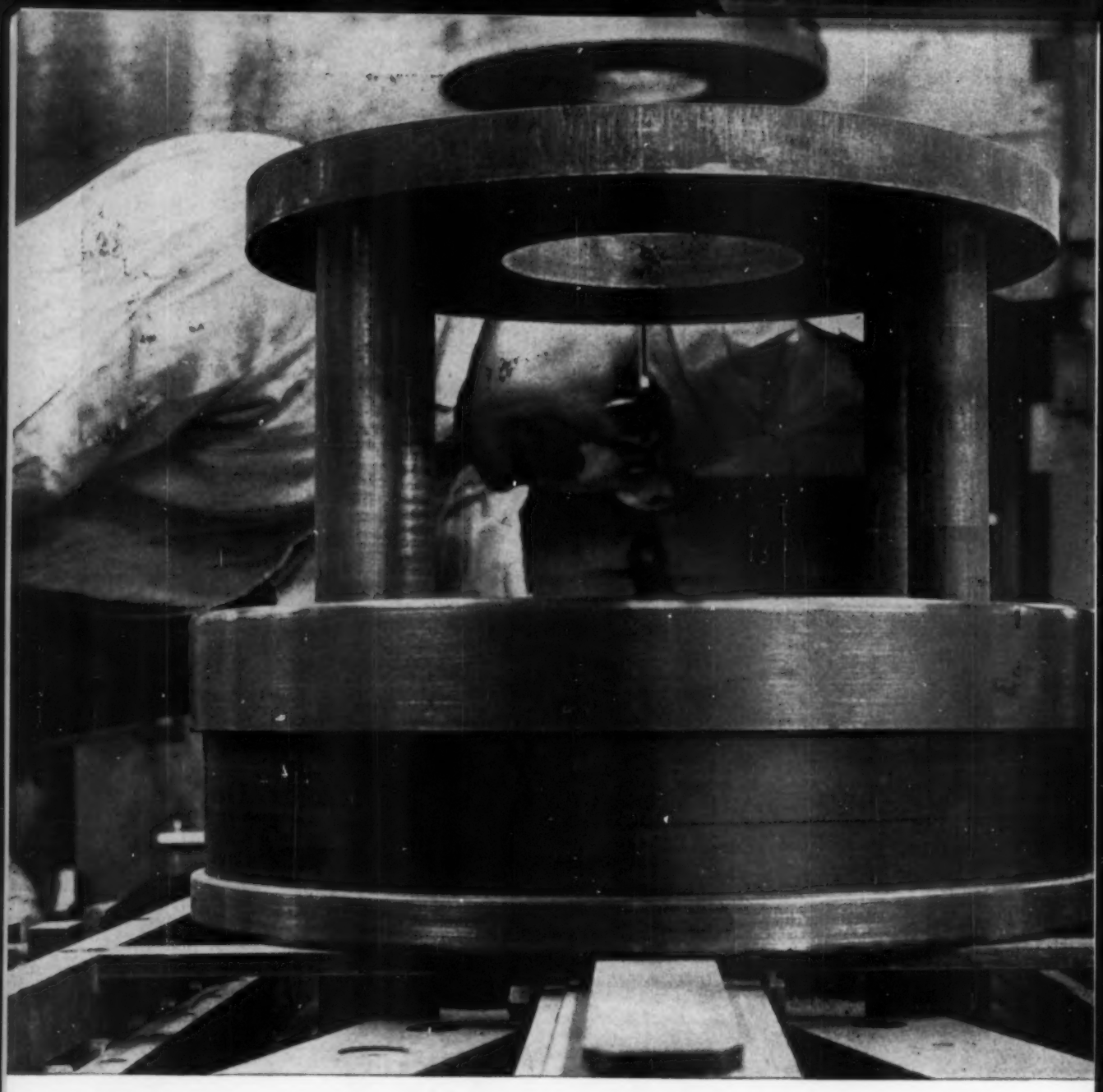

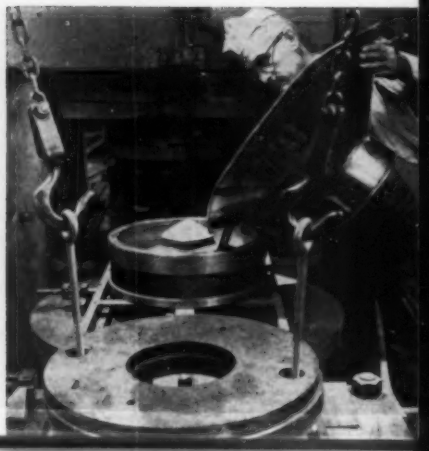

Here's a tough old squeezer that won't wear out

The donut-shaped steel disc in the main illustration is the mold plate used in a large hydraulic press. Under 2,000 tons of pressure, it squeezes an abrasive mixture in a mold to make grinding wheels. It's a tough job, and Waltham Grinding Wheel Company had to replace these discs every few months because they wore down and became unbalanced. Replacements were expensive and they wasted production time.

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"T-1" constructional alloy steel has a minimum yield strength of 100,000 psi. It is exceptionally tough and resistant to abrasion—can be furnished heat treated to a minimum hardness of 321 Brinell. Compared to carbon steel, it has four times more resistance to atmospheric corrosion. In spite of its strength and toughness, "T-1" Steel can be formed, machined and welded. And because of its strength, it can be used in lighter gages, reducing weight as much as ⅔, depending on the application.

If you would like to have complete information about "T-1" Steel, write for our book "USS 'T-1' Steel," United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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USS

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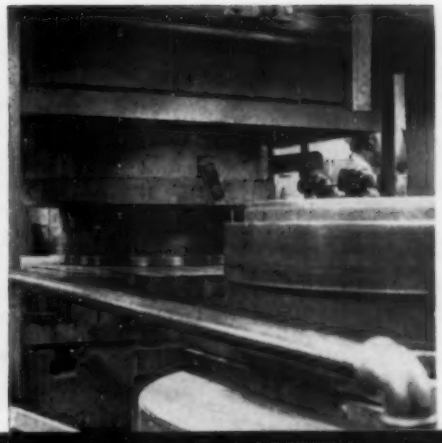
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel



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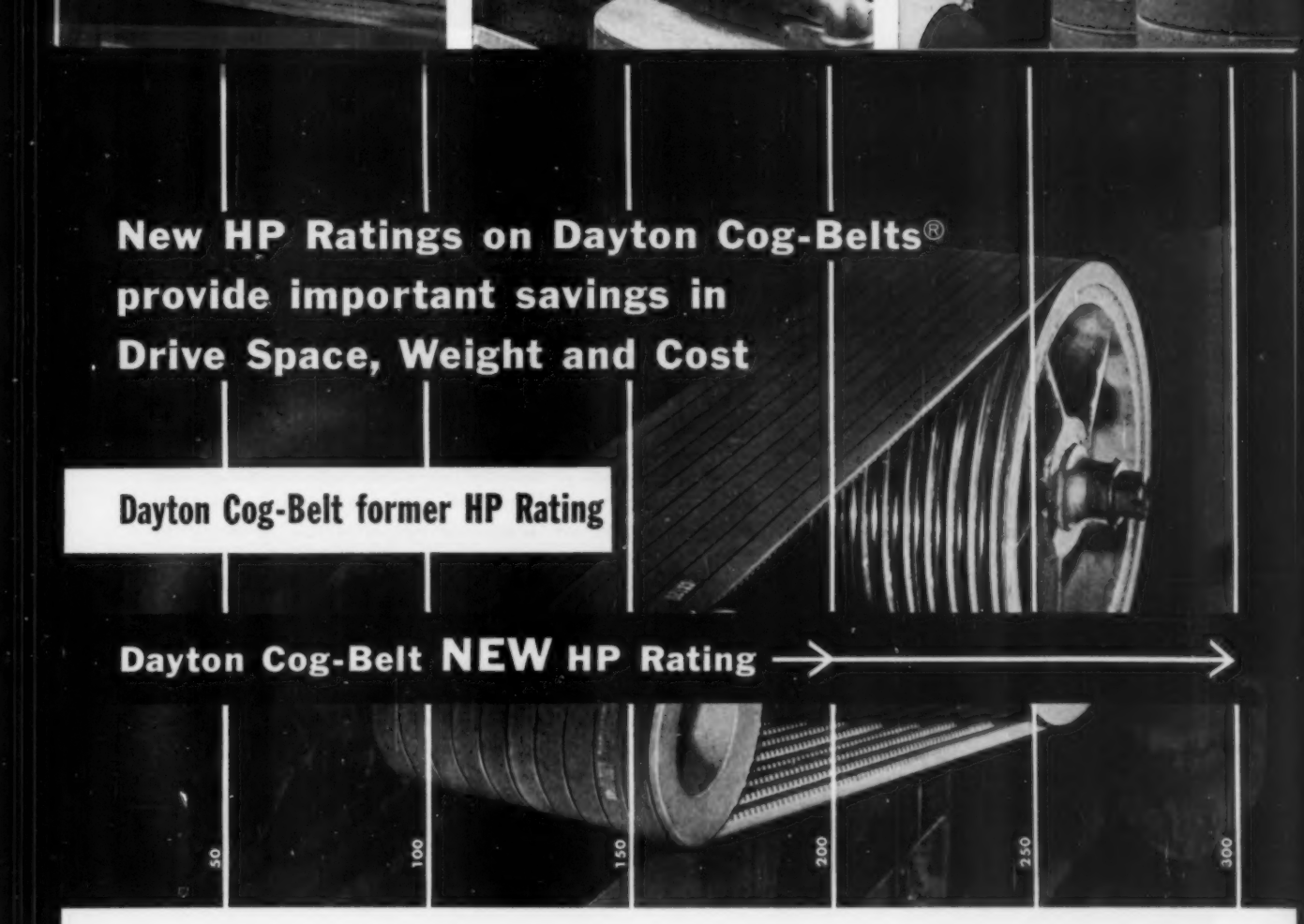
New HP Ratings on Dayton Cog-Belts® provide important savings in Drive Space, Weight and Cost



Dayton Cog-Belt Horsepower Capacity increased to 200-300% of previous Standard Belt Ratings . . . using existing industry-standard sheaves

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- Job-proven Dayton quality is backed by the experience of many actual drive applications throughout industry.
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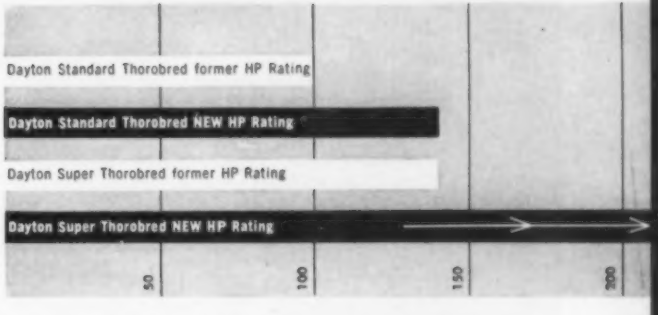

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Utilize over 30 years of time proven Dayton quality, research and engineering in your V-Belt drive design.

Dayton Industrial Products Co.

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CIRCLE NO. 57 READER SERVICE CARD

Armco PH 15-7 Mo Stainless Selected for Mach 3 B-70 and

High strength, resistance to heat and corrosion, and good fabricating characteristics of three special Armco PH Stainless Steels not only meet requirements for 2000 mph aircraft but improve the performance of a wide range of products.

The U. S. Air Force B-70 "Valkyrie," intercontinental bomber, and the F-108 manned long-range interceptor, are designed for speeds of 2000 mph at altitudes over 70,000 ft. To withstand the combination of heat and stresses imposed by such performance, these aircraft must be constructed of special metals. Armco PH 15-7 Mo Stainless has been selected as the major material for sheet metal construction of both aircraft. It provides the needed high strength at temperatures up to 1000 F, corrosion resistance and workability for honeycomb panel wings, fuselage, and control surfaces as well as other key structural airframe members.

The selection of PH 15-7 Mo to achieve top performance in these aircraft is typical of the extensive use of Armco's family of high strength precipitation-hardening stainless steels.

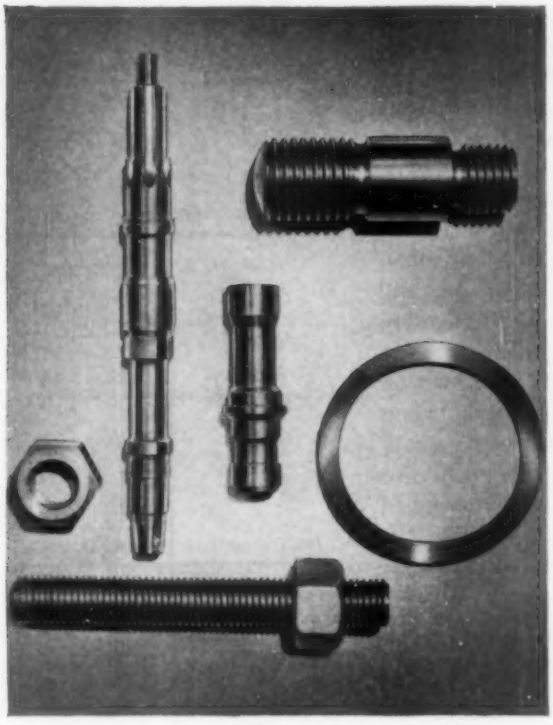
Used in Many Products

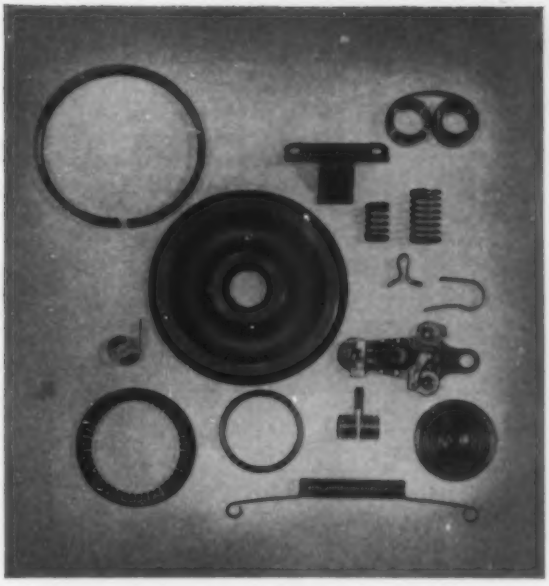
For parts that must have high strength at temperatures

Steel F-108 Aircraft

to 1000 F, good corrosion resistance and excellent fabricating characteristics, PH 15-7 Mo offers unusual advantages. In addition to its use for many aircraft components, this special Armco Stainless is specified for industrial products that must give top performance under severe operating conditions.

Consider the added saleability you can give *your* products by improving their performance with Armco's Precipitation-Hardening Stainless Steels. Just fill out and mail the coupon for complete information on special and standard stainless steels produced by Armco. We'll send you data promptly.





Armco 17-7 PH—Designers of all kinds of products ranging from watch springs, saws and electric switches to airplanes have utilized the strength, corrosion resistance and excellent fabricating characteristics of Armco 17-7 PH Stainless Steel. Tensile strengths up to 350,000 psi, plus the ability to resist heat and corrosion, have made it an especially useful spring material.

Armco 17-4 PH—This special Armco Stainless Steel is specified extensively for shafts, bolts, special studs and other applications where strength plus corrosion resistance mean longer, dependable service at less cost. The high hardness, strength and durability of 17-4 PH combine to resist corrosion-fatigue, abrasion and erosion-corrosion. Its simple 950 F heat treatment also cuts production costs.

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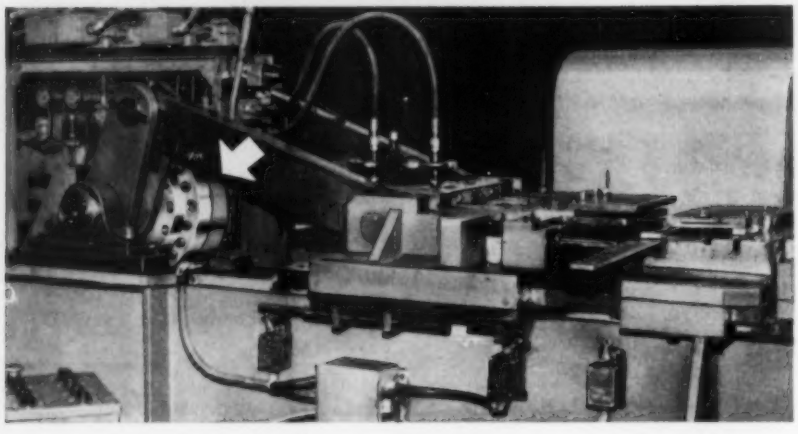
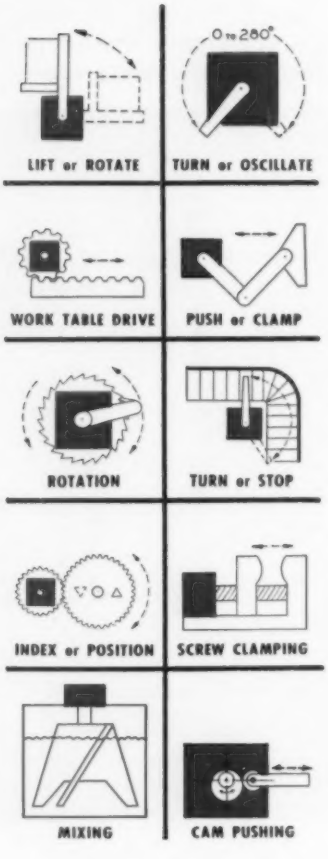
EXERTS 60-TON FORCE

. . . *In 1/6th the Space of a Straight-line Actuator!*

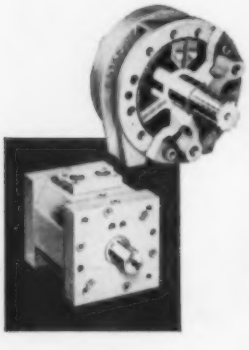


Left: **Every 1½ minutes, a Model HN Rōtac Torque Actuator on this wire-forming machine exerts a 60-ton force on the work through a simple toggle arrangement. Higher torque and higher speed—in a fraction of the space required by a straight-line power unit, control valves and motor—add up to Rōtac efficiency! (Photo courtesy Stubnitz Greene Corp.)** ***Below:*** **These typical Rōtac applications might suggest the answer to your design problem:**



Rōtac Reciprocating Rotary Torque Actuators are designed to do more jobs that cannot be done easily or economically with other devices. **Torque** is instantaneous and uniform through the required arc. **Ratings** range from 100 to 40,000 inch-pounds for standard single-vane models, from 240 to more than 200,000 inch-pounds in double-vane models. **Power source** can be air, oil or other fluids, with operating pressures to 1,000 psi in standard Rōtac units. **Mounting** can be vertical, horizontal or at any angle, and RN models can be safely manifold mounted. **Rotation or oscillation** (to 280° in single-vane models) can be stopped, started, slowed down or speeded up. **Application** is unlimited; among hundreds of uses are mobile installations, machine tool and various light and heavy industrial applications. **Construction** conforms to J.I.C. standards, and to Ex-Cell-O's own high requirements for precision, long life and low maintenance. **Special designs** available for unusual applications, military and aircraft use. **Delivery** of a wide range of standard catalog models is fast. See your local Rōtac Representative or write direct.

59-R-2



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PERSPECTIVES

in design and development . . .

Secrecy and the Technical Press

Senator Clinton P. Anderson, chairman of the Joint Committee on Atomic Energy, went on a top-secret trip to observe some atomic tests. A delay occurred and he telephoned his wife. She told him exactly where he was going and why he had been delayed—she had read about it in the Washington *Times-Herald*! . . . Last March 19 the New York *Times* published details of the very secret high-altitude nuclear blasts called Project Argus. The *Times* got the details through its own reporting staff, not from a Defense Department news release . . . *Aviation Week* finally broke the story of our radar setup in Turkey, about which the USSR must certainly have known long before—a radar station is hard to hide . . . PRODUCT ENGINEERING's story of the Polaris-carrying sub (Feb 23) included a log of security "torpedoes" that almost sank the story before publication.

Russian technical data has been translated, and promptly classified. Why? The Turkish radar station certainly knows the ratio of aborts to successes in Sputnik and ICBM firings in the U.S.S.R. Telling these things to the American public cannot hurt us—and may help the layman understand the problems and the situation.

Such "classified" muddles are rife. Probably most engineers engaged in secret work have, one time or another, seen reports on which the "secret" tag sat like Sinbad's Old Man of the Sea. Sen Anderson discusses several examples in an article in the *New York Times Magazine*. One concerns the radiation-scorched tail feathers of sooty terns—was a "secret" tag justified on a letter about these birds? Sen Anderson doesn't think so and offers a partial solution: The AEC should publish its own technical journal. Furthermore, he says, the classifier of information should have to prove his "secret" tag is really necessary. In other words, we can gain more by allowing scientists and engineers to know what problems exist than by restricting these problems to relatively few people.

Why Delay the Facts?

But Sen Anderson makes another point—concerning a scientific journal's article on the amount of strontium 90 in young children. He feels information of such importance to the country should not "gather dust for many months on the shelves of 'prestige' journals before it finally comes to light." Because certain scientists prefer to publish data only in the pages of society journals, vital information is delayed and held back by "publishing bottlenecks" of six months or more. And there is added delay waiting for a paper to be scheduled on a meeting program. In Russia, we hear, this all takes "less than a month."

Sen Anderson makes sense with his proposals for an AEC journal, and for speedy publication of important data in the less esoteric media that have wider readership. But why has he overlooked one area here—the business publications? Much technical information from the AEC is of interest in one way or another to industry. When edited so that its most important facts are communicated accurately, but also clearly and swiftly, it has maximum value—all the more so when the specific is segregated from the general. Furthermore, such information comes out all the faster through present-day stepped-up publishing schedules of many business magazines.

Finally, all this can apply not only to what the AEC is doing; it is equally valid for other technical information. This includes any technological progress that is likely to interest industry or business—whether the source is government, industry or private individuals. —Douglas C Greenwood

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Product Engineering

HORIZONS

June 22, 1959

SPACE-HAPPY?

Moon-madness, stir-craziness, gold-fever—and now space-happiness. No issue of magazine or newspaper misses a chance at vague blue-sky stories of moon bases and Martian stopoffs. No budget in Washington gets so few questions as one dealing with outer space. The drums beat, the politicos pronounce, the military views with alarm.

Meantime, who deals with the problems of our ultra-expensive surpluses, education, public roads, displacement of manpower by automation? Who works on military development for limited war? Who, in plain English, tends store while we jaunt to Jupiter?

Thus has it ever been. The public wagon is tied to a star. We have no quarrel with exploration, with striking out into the unknown. It's a way to stir up the national corpuscles. So, on to outer space!

But any all-out exploratory effort is usually preceded by careful preparation, and here we're shooting at Venus before we've hit the moon—or indeed before we've perfected a ballistic rocket that we can send a precise, limited distance.

Perhaps this is all of a piece with the present Washington emphasis on science and scientists. These are the magic words: "Make way for science!" If you want to get something in Washington, hang a science label on it; if you want to be somebody, say you're a scientist. And the brush fire from Washington spreads in all directions; students show a preference for science over engineering, engineers call themselves scientists, laymen rush to find the remark scientific to drop at cocktail parties.

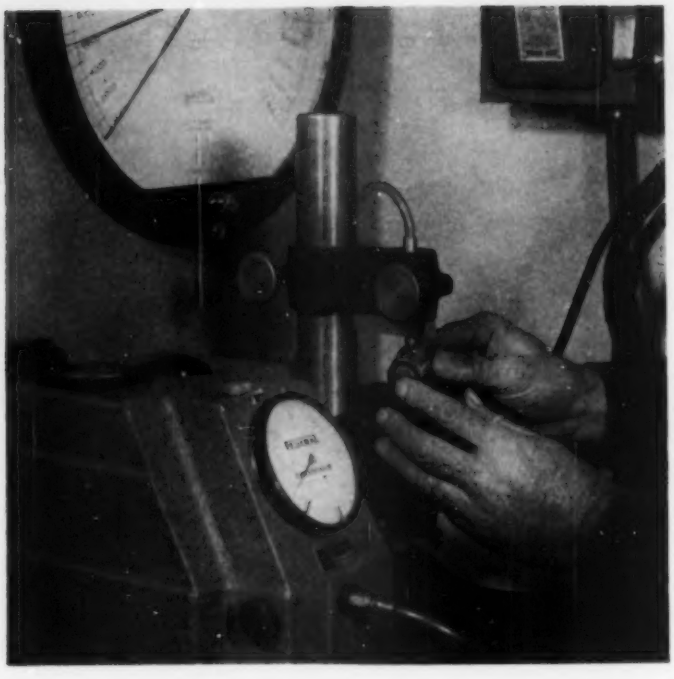
American scientists tell me that the way to get exotic equipment is to say the Russians already have it; Russians told me that they fortify doubtful budgetary requests with the addendum that "the Americans have it." And both groups do very well, particularly if the project is a really "gone" one. Thus does "keeping up with the Joneses" become an international gambit, and space fever takes its toll in high places.

In the name of all that's practical, let's watch it. That label "scientist" can be hung on almost anybody, including the utterly impractical pseudo-scientists and the scrambled eggheads. Let's hold out for sanity, for engineering—which is science with a sense of purpose. Let's stay at least somewhere within shooting distance of things that can be produced as hardware. Let's crawl before we walk.

Let's, in short, remember that we're engineers, and that engineers must be the voice of experience in a babble of theories, the disciplined minds, amid the enthusiasts, the gadflies amid the gadgeteers—dreamers all right, but with a sense of direction among the space-happy.

K. Tangerman

Here is a simple way to find the coefficient of friction when surfaces slide at high loads and low velocities. Charts list values for over 50 candidates.



press-fit test picks . . .

SOLID LUBRICANTS for EXTREME PRESSURES

A SONNTAG, *president, Alpha-Molykote Corp, Stamford, Conn.*

The danger of galling increases when bearing pressure goes up or sliding velocity goes down—and those also happen to be precisely the conditions when the press-fit test can give a rating on solid lubricants. It supplies the answer to a question that isn't easy: "What is the coefficient of friction?" Yet the method is simple, sensitive and reliable. And it utilizes equipment already available in most plants.

In this test, an oversize pin is pressed into a bushing. For best accuracy, a compression or universal testing machine is used, the inaccuracy of which usually does not exceed ±1%. The indicated force needed to press the pin into the bushing at about 0.6 in. per min. is called the kinetic friction force. For static friction, the indicated force to start a fully inserted pin into motion is used.

With these two forces, the static and kinetic friction coefficients can be calculated if the radial press-fit force can be found. This force is most easily determined from the interface pressure as calculated from the increase in bushing diameter. All that's needed is an instrument with an indicating accuracy of 0.00001 in. —an air gage, for example. An OD measurement before and after insertion, taken halfway along the bushing, gives the diametral expansion e. The following standard equation for thick-walled cylinders under internal pressure gives interface pressure p in terms of bushing radii A (inner) and B (outer) and elastic modulus E:

$$P = \frac{E\,(B^2 - A^2)\,e}{2\,A^2B}$$

Then the coefficient of friction f—either static or kinetic—is computed:

$$f = \frac{\text{indicated force on pin}}{\text{contact area} \times \text{interface pressure}}$$

Metals and Pressures

Basing the test on "before" and "after" OD's will compensate for slight interference differences between one set of specimens and the next. Table I shows dimensions and finishes for one possible set for steel-to-steel friction measurements. Possible interference is from 8-12 mils —representing pressures in the order of 15,000 psi as shown by the chart. For

materials other than steel, a different chart must be calculated. This is true whether pin and bushing are made from the same or from dissimilar metals. The interface-pressure equation applies to the case of dissimilar metals because it is based on the deformation of a thick-walled cylinder —without consideration of the source of pressure, as would be done in a shrink fit. Modulus used, of course, must be that of the bushing.

Design usually worries about extreme bearing pressures when they exceed 300-500 psi. Actually, in the absence of hydrodynamic lubrication, calculated bearing pressures of a few psi may result in galling. Since it is impossible to produce an infinitely smooth surface, and contact is at a few surface peaks, the real area of contact is a small portion of the calculated bearing area. Thus the yield point of the metal can be reached locally at very low loads.

Factors to be simulated in a practical test are: bearing metal combinations, surface finish, sliding velocity and the approximate range of the bearing pressures expected. The press-fit tests permit these simulations at low cost. The exact duplication of bearing pressure did not appear too critical for solid lubricants discussed here, since variations in results were negligible in the range of interface pressure from 7500 to 15000 psi.

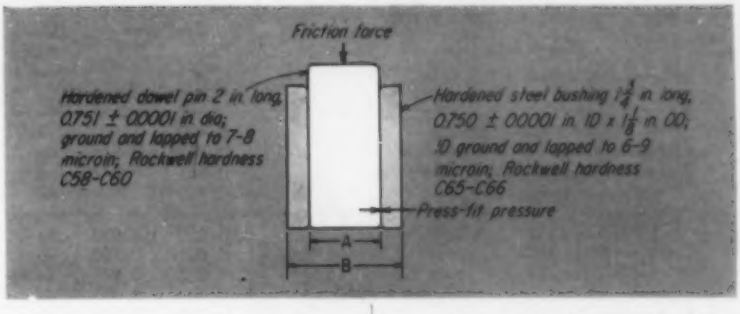
Galling and Seizing

In addition to being cheap, the pin-bushing test will detect galling and seizing easily. This is because such trouble is accompanied by "slip stick" noise or perceptible vibrational shudder in the machine, along with visible vibration of the load needle. From experience, any combination of bearing metal and lubricants exhibiting slip-stick behavior in this test will not perform in practical low-velocity applications. Latheways are a good example: When cutting some alloys at very fine feeds, high pressure between tool and work, when transmitted to the ways, can cause enough slip-stick shudder to ruin the surface finish being produced.

In general, static friction is higher than kinetic friction—especially where lubrication is involved. Large differences mean that the effort required to initiate motion will be high, and that fluctuations of effort may result

Table I—Press-fit Conversion Chart

(for configuration shown only)


Friction force
Hardened dowel pin 2 in. long, 0.751 ± 0.0001 in. dia; ground and lapped to 7-8 microin; Rockwell hardness C58-C60
Hardened steel bushing 1 3/4 in. long, 0.750 ± 0.0001 in. ID x 1 1/8 in. OD; ID ground and lapped to 6-9 microin; Rockwell hardness C65-C66
Press-fit pressure
A
B

Bushing OD expansion, inches	Radial pressure, psi	Radial force, lb	Bushing OD expansion, inches	Radial pressure, psi	Radial force, lb
.00070	11,500	43,930	.00090	14,780	56,460
.00071	11,660	44,540	.00091	14,950	57,110
.00072	11,830	45,190	.00092	15,110	57,720
.00073	11,990	45,800	.00093	15,280	58,370
.00074	12,150	46,410	.00094	15,440	58,980
.00075	12,320	47,060	.00095	15,600	59,590
.00076	12,480	47,670	.00096	15,770	60,240
.00077	12,650	48,320	.00097	15,930	60,820
.00078	12,810	48,930	.00098	16,100	61,500
.00079	12,980	49,580	.00099	16,260	62,110
.00080	13,140	50,200	.00100	16,430	62,760
.00081	13,300	50,810	.00101	16,590	63,370
.00082	13,470	51,460	.00102	16,750	63,990
.00083	13,630	52,070	.00103	16,920	64,630
.00084	13,800	52,720	.00104	17,080	65,250
.00085	13,960	53,330	.00105	17,250	65,700
.00086	14,130	53,980	.00106	17,410	66,510
.00087	14,290	54,590	.00107	17,570	67,120
.00088	14,450	55,200	.00108	17,740	67,770
.00089	14,620	55,850	.00109	17,900	68,380

Why Solid Lubricants?

When two sliding surfaces are completely separated by a liquid film, ideal hydrodynamic lubrication occurs, energy conversion approaches 99.8%, and wear is practically nil. But when loads get very high or sliding velocities very low, complete separation breaks down—and the peaks of machined surfaces begin to scrape each other. Wear, as well as seizing and galling, then becomes difficult to avoid. In fact, it has been estimated that half the world's energy supply is consumed by this boundary friction.

All base metals protect themselves to some degree with solid lubricants—thin oxide films that develop within a few minutes after machining. These films do a rudimentary job of lubrication, but as the surface peaks are sheared off under extreme loading, there is usually insufficient time for new oxide films to form. By adding slippery solids that will not squeeze out when loads go up and velocity drops, nature's own defensive mechanism can be assisted—as shown in the accompanying tables.

These solid, extreme-pressure lubrication aids can be applied as dry powders, as additive to greases, or suspended in liquid carriers. They can perform the lubrication job themselves, or they can be supplemented by additives which react chemically with the bearing surface to manufacture solid lubricants in position during operation. Here, the carrier is usually a liquid which also serves as a convenient means to distribute frictional heat.

Table II—Friction Coefficients

(steel-to-steel, except as noted)

	Lubricating medium	Coefficient		Slip-stick seizure
		Kinetic	Static	
Surface Treatments	No lubricant or coating	0.400	.....	yes
	Fe-Mn phosphate coating	0.213	0.218	no
	Fe-Mn phosphate + MoS_2 rubbed in	0.067	0.074	no
	Molten sulfide salt bath (1050 F)	0.242	.....	no
Metal Sulfide Powders	Molybdenum disulfide (MoS_2), natural	0.050	0.053	no
	Molybdenum disulfide, synthetic	0.091	0.106	no
	MoS_2, natural (steel on bronze)	0.075	0.078	no
	MoS_2, natural (WC on WC; p = 100,000 psi)	0.034	0.031	no
	Tungsten disulfide	0.090	0.098	no
	Titanium disulfide	0.25+	.....	yes
	Tellurium disulfide	0.25+	.....	yes
	Selenium disulfide	0.25+	.....	yes
Metal Powders (2–175 microns dia)	Aluminum (with 2% stearic acid)	0.25+	.....	yes
	Antimony	0.25+	.....	no
	Copper	0.25+	.....	yes
	Indium	0.25+	.....	yes
	Lead	0.25+	.....	no
	Silver (commercial oil-silver paste)	0.095	0.101	no
	Tin	0.25+	.....	yes
	Zinc	0.186	0.217	no
	Copper-zinc alloy (85/15)	0.226	0.341	no
	Cu-Zn-Al alloy (70/29.75/0.25)	0.25+	.....	yes
	Cu-Pb powder mixture (50/50)	0.183	0.222	yes
Miscellaneous Solids	Barium hydroxide	0.151	0.163	no
	Borax	0.210	0.226	no
	Boron nitride	0.25+	.....	yes
	Graphite, natural	0.25+	.....	no
	Graphite, colloidal in water	0.100	.....	no
	Kaolin	0.25+	.....	yes
	Lead chloride	0.191	0.214	no
	Leaded zinc oxide	0.25+	.....	yes
	Mica	0.25+	.....	yes
	Rottenstone	0.189	0.195	no
	Silver iodide	0.231	0.245	yes
	Talc	0.25+	.....	yes
	Vermiculite	0.160	0.167	no

Table III—Friction Coefficients

(Low-melting-point materials)

	Lubricating medium	Melting range, °F	Coefficient		Slip-stick seizure
			Kinetic	Static	
Waxes	Spermaceti	108–117	0.048	0.062	no
	Beeswax	140–145	0.050	0.055	no
	Bayberry	113–119	0.054	0.070	no
	Synthetic wax (commercial)	201–207	0.061	0.062	no
	Polyethylene glycol (high mol. wt)	127–133	0.077	0.078	no
	Hydrogenated tallow glyceride	138–145	0.082	.....	no
	Candelilla	153–158	0.099	0.113	no
	Paraffin	120–170	0.104	0.112	yes
	Montan	172–194	0.108	0.120	yes
	Microcrystalline wax	180–188	0.132	0.151	no
	Carnauba	181–187	0.143	0.169	no
	Wax stick (for saws, etc)	160	0.179	0.294	yes
Powdered stearates	Diethylene glycol stearate	129–138	0.083	0.089	no
	Calcium stearate	315–325	0.107	0.113	no
	Aluminum stearate	265–318	0.114	0.119	no
	Sodium stearate	390–410	0.164	0.192	yes
	Li-12-hydroxy stearate	410–420	0.211	0.218	no

in seizing when velocities are low. Conversely, when the coefficients are nearly identical, uniform speed between slow-moving sliding parts is easy to maintain. A note of caution: Before discarding a particularly desirable combination of materials because the coefficient difference is large, try repeated insertions to see whether the surfaces "wear in" quickly.

Some Results

Accompanying tables report the results of a series of press-fit tests on a large number of solids as possible extreme-pressure lubricants or as anti-seize compounds. Specimens were as shown in Table I, except as noted. Sliding velocity was 0.6 in. per min. in all cases. Where coefficients of 0.25+ appear, the test was discontinued because the load exceeded fixture capacity and the pin could not be fully inserted. All test lubricants except the waxes were applied manually in powder form by vigorous rubbing with a clean dry cloth; waxes were brushed onto both pin and bushing in melted form. Frictional or operating temperatures exceeding the melting ranges set out in the table may result in loss of lubricating action.

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EDITOR'S NOTE: Other articles covering important aspects of friction and wear include the following:

"Wear of Lubricated Surfaces," Apr 13 '59, p 74—staff report of ASME symposium covers recently developed techniques on isotope tracers, wear coefficients, gear-tooth profiles and engine additives.

"ASLE Gear Symposium," Feb 16 '59, p 64—staff report reveals some unusual thinking on wear of oscillating parts, leading to a generalized wear equation for this type motion.

"More Surface Polishing—Less Galling," Nov 24 '58, p 63—shows why parts should be "worn-in" before they take loads and why cast irons are less likely to gall than steels or brasses.

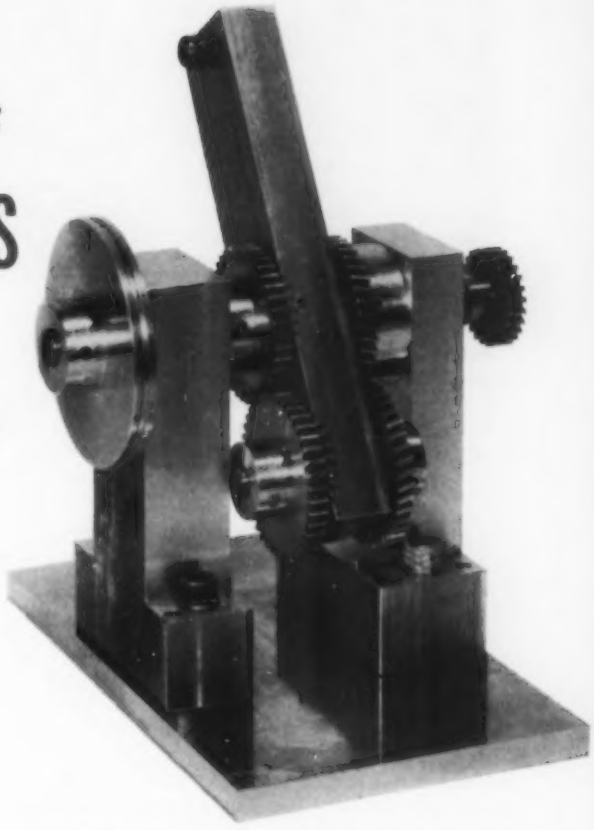
"Considerations for Friction Materials," Design Digest Issue Mid-Sept '58, p C16—discusses the nature of friction materials, their characteristics and how to choose them by means of selection chart.

"Predict Wear of Metal Parts," June 23 '58, p 71—presents new design coefficients to account for galling; discusses conditions of lubrication, surface cleanliness and surface cracks.

novel concept gives RECORD GEAR RATIOS

By pairing helical with spur gears in an otherwise standard planetary system, the author's method provides fantastically high speed-reductions.

SIGMUND RAPPAPORT, *kinematician*
Ford Instrument Co, Div of Sperry Rand Corp



Author's version substitutes helical gears for one of the two sets of spur gears and boosts reduction ratio from 1:21 to 1:1600.

Here's a modification that will greatly increase the speed-reduction capabilities of an ordinary planetary gear system. It involves no drastic changes—just substitute a selected pair of helical gears for one of the two pairs of spur gears in the planetary train.

Though the gear assembly remains the same in size and weight, this simple change can easily boost the reduction ratio from, say, 1:21 to 1:1600. But any epicyclic gear train has this limitation—at high reduction ratios it will multiply torque to a maximum of 40:1, as will be shown later. This, however, does not prohibit its usefulness for low-power, high-reduction applications.

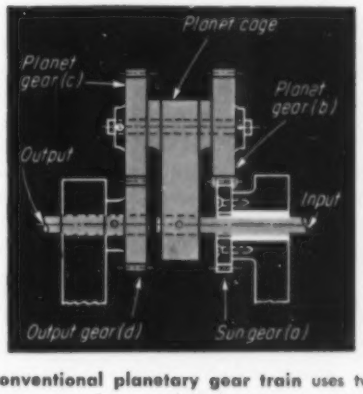
Where the Difference Lies

Capabilities of the spur-helical system are explained by the same simple equation that shows the conditions in a conventional four-spur planetary system. The latter, illustrated at the right, is "epicyclic" because its planet gears roll around the outside of center gears (with a "hypocyclic" type, the planet rolls on the inside of an internal ring gear). Gear a is fastened to the frame, the input shaft revolves the cage, and the size differences between the two gear sets (a and b; c and d) causes the output gear to revolve. The angular displacement (or velocity) ratio, r, between output and input is

$$\frac{\text{output displacement}}{\text{input displacement}} = r = 1 - \frac{ac}{bd} \qquad (1)$$

where symbols a, b, c and d can be considered as the number of teeth, or pitch diameters, of the respective gears.

A condition here is that center distance between gears a and b must equal center distance between gears c and d. Also, for a high reduction, the fraction in the equation should come close to unity without reaching it.



Conventional planetary gear train uses two sets of spur gears for speed reduction. A train like this (analyzed in article) gives only a 1:21 ratio.

(Unity occurs when both sets are identical i.e. $a = d$, and $b = c$. The cage then "idles" around the output gear without driving it).

Suppose space considerations limit the gears to not more than 41 teeth—what would be the highest reduction achievable? Mathematical analysis reveals that a, b,

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ABOUT THE AUTHOR

Mr. Rappaport, well known for his articles on unusual but practical mechanisms, is also adjunct professor at Polytechnic Institute of Brooklyn. His course on applied kinematics, taught to Brooklyn Poly's graduate students, is brightened by the models he brings in of strange-looking devices he developed at places as far away as an automatic-machine factory in Austria.

He holds 11 patents in Europe and in this country, and has 7 more pending. But he says the planetary gear system described here cannot be patented because it is based on purely mathematical considerations.

c and d should differ from one another by as little as possible, which yields, as possible teeth numbers, 39 and 40 in addition to the given 41. By maintaining $a + b = c + d$, the best that can be done is $a = 40$, $b = 41$, $c = 40$, $d = 41$, resulting in the ratio:

$$r = 1 - \frac{(40)\,(40)}{(41)\,(41)} = \frac{81}{1681} \approx \frac{1}{21}$$

which is not a very high reduction.

A higher reduction is possible if $b = c$. Thus: $a = 40$, $c = 41$, $d = 41$, resulting in the ratio:

$$r = 1 - \frac{(40)\,(41)}{(41)\,(41)} = \frac{1}{41}$$

This will mean, however, that $a + b$ does not equal $c + d$. Designers usually overcome this inequality in one of two ways:

- Insertion of idler gears between gears a and b, and between c and d. The idlers are carried around by the planet-arm and their positions are determined by their size (which is immaterial).
- Cutting the teeth of the gear pair whose teeth sum is the larger, to a greater depth and making their OD accordingly smaller. This amounts to modifying their pitch—making it somewhat finer.

Neither method can be recommended. The first makes the drive heavier, less efficient and more expensive; the second is bad practice because it results in a nonstandard tooth form.

Spur-helical Method

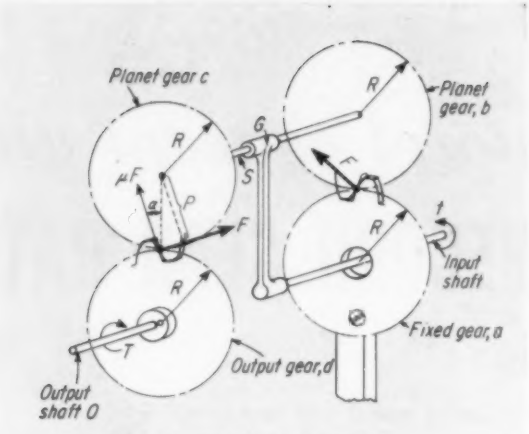
Unequal sets of gears can be used if one set consists of helical gears. Here's how this affects the speed ratio:

There is a difference in pitch diameters between spur and helical gears. For spur, $PD = n/DP$, while for helical, $PD = n/DP \cos \beta$, where PD = pitch dia, DP = diametral pitch, n = number of teeth, β = helix angle.

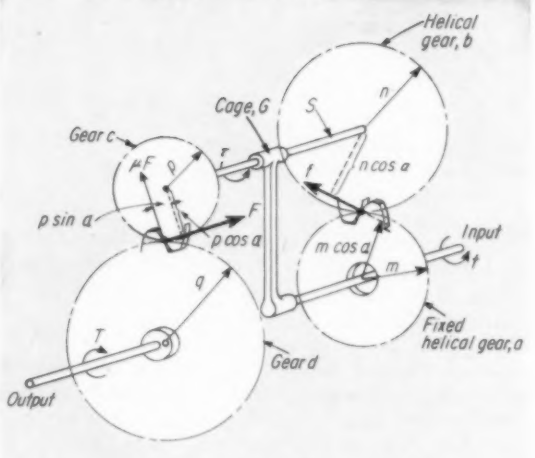
This means helical gears can be employed as the gear pair with the smaller sum of teeth if β is determined from

$$\cos \beta = \frac{a + b}{c + d} \qquad (2)$$

This increases the pitch diameter of the helical gears by a factor of $1/\cos \beta$, and causes the center distance between gears a and b to become exactly equal to the center distance between c and d. Thus, the method escapes the disadvantages of extra gears or nonstandard tooth form, and is far superior. Let us see how high a speed reduction is possible in exactly the same space as the 1:21 or 1:41 drives.



(A) FOR GEARS OF SAME SIZES



(B) FOR GEARS OF DIFFERENT SIZES

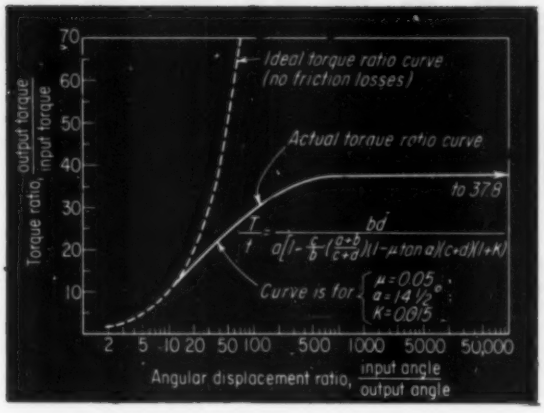
Among the 144 possible planet assembly combinations of gears with 39, 40 and 41 teeth, the one resulting in the highest ratio is found with $a = 39$, $b = 40$, $c = 41$, $d = 40$. Thus:

$$r = 1 - \frac{(39)(41)}{(40)(40)} = 1 - \frac{(40-1)(40+1)}{40^2} = 1 - \frac{1600-1}{1600} = \frac{1}{1600}$$

Here, gears a and b are helical, with a helix angle of 12°45′. (A model of such a drive is shown in photo on page 67. The small pinion is the input, the pulley the output, and the output shaft makes one revolution when the input shaft turns 1600 times. Generally, the ratio becomes: $r = 1/n^2$, when one planet and the output gear each have n teeth, the fixed sun gear has $n - 1$ teeth and the second planet has $n + 1$ teeth. Thus, for a gear ratio of 1:3600, $r = 1/(60)^2$, and $a = 59$, $b = 60$, $c = 61$, $d = 60$, $\beta = 10°25'$.

Friction Losses

If there were no friction losses between the gear teeth and at the shaft bearings, ratio between input and



Torque limitation . . .
of epicyclic gear trains—curve shows tapering off to a 37.8 torque ratio.

output torques would be the reciprocal of the displacement ratio. But actually a large part of the input torque (or, to be exact, input work) is used up in overcoming friction.

To find the effect of friction in any epicyclic gear train, assume first all gears are of equal size. This results in a displacement ratio of $1/\infty$ or zero—if the input shaft is turned, the output shaft will remain at rest. For a frictionless gear system, the smallest input torque would be sufficient to turn the input shaft, no matter what load is applied to the output shaft. But actually the following will happen if a torque load T is applied to shaft O—see (A) on opposite page. It results in a tooth pressure force F normal to the tooth flank, thus creating a friction force equal to μF, where μ is the friction coefficient. Two torques, FP and $-\mu FP \tan \alpha$ then act on gear c, where R is the pitch radius, α is the pressure angle and $P = R \cos \alpha$. The friction torque created in the planet bearing G is proportional to the torque on the planet shaft S. The torque between c and d is counteracted by the torque between the fixed gear a and b; but to turn the input shaft the following torques must be overcome:

Friction torque between c and d = $\mu FP \tan\alpha$
Friction torque between a and b = $\mu FP \tan\alpha$
Friction torque at G = $K\ (2\mu FP \tan\alpha)$

adding up to $2\ \mu FP \tan\alpha\ (1 + K)$, where K is the friction loss coefficient for the planet bearings.

Thus, the torque t necessary just to turn the input shaft without delivering any useful work (because the output rests) is $t = T\ (1 + K)\ 2\mu \tan \alpha$. Thus:

$$\frac{T}{t} = \frac{1}{2\ \mu\ tan\ \alpha\ (1 + K)} \qquad (3)$$

For typical constants of $\mu = 0.05$, $K = 0.015$ and pressure angle $\alpha = 14\frac{1}{2}°$, the ratio between output and input torque $T/t = 37.8$. This condition is independent of size of the four gears, providing they are all the same size.

For the general case of gears of different sizes—see sketch (B)—with gears having pitch radii of m, n, p and q, the torque τ which acts on the planet shaft S and is produced by the output torque T and transmitted back to the input is: $\tau = Fp \cos \alpha - \mu Fp \sin \alpha$.

This torque produces a tooth pressure force f of $\tau/n \cos \alpha$ between gears a and b, hence

$$fn \cos \alpha = Fp\ (\cos \alpha - \mu \sin \alpha) \qquad (4)$$

and

$$f = F(p/n)(1 - \mu \tan \alpha) \qquad (5)$$

The input torque t therefore must supply $(F - f) \times (m + n)$ plus the friction torque created in the planet bearings G, which is proportional to the applied torque. Hence

$$t = (F - f)\ (m + n)\ (1 + K)\ (m/n) \qquad (6)$$

where K is the friction loss coefficient in the planet bearings and the last term is caused by the ratio between sun gear and first planet.

From Eq (4), (5) and (6), and keeping in mind that T is proportional to F:

$$\frac{T}{t} = \frac{nq}{m\left[1 - \frac{p}{n}\ (1 - \mu \tan \alpha)\right]\ (m + n)\ (1 + K)} \qquad (7)$$

It is more convenient to calculate with numbers of teeth than with pitch radii. This requires taking into account that $m + n = p + q$, even if $a + b$ is not equal to $c + d$. Thus, if m and n are the helical gears and a and b their respective numbers of teeth, both a and b must be divided by cos β. But $\cos \beta = (a + b)/(c + d)$ and Eq (7) becomes:

$$\frac{T}{t} = \frac{bd}{a\left[1 - \left(\frac{c}{b}\right)\left(\frac{a+b}{c+d}\right)(1 - \mu\ tan\ \alpha)\right]\ (c+d)\ (1+K)} \qquad (8)$$

When all gears are of equal size, $a = b = c = d$, and Eq (8) degenerates into Eq (3). Thus the torque ratio approaches a constant value when the reduction ratio approaches $1/\infty$. The semilogarithmic graph on this page shows clearly how the curve approaches the limiting value asymptotically.

Test Results

Tests performed on a 1:1600 model showed that for input torque ranging from 1 in.-gm to 520 in.-gm the torque ratio ranged from 1:39 to 1:37.8, which agreed quite well with the theoretically derived value of 1/37.8.

How does this compare with torque ratios obtainable by an ordinary spur gear train of, say, 5 meshes? Assuming a 94% efficiency per mesh, the torque ratio would be: (1:1600) x 0.94^5 = 1:1150. But 10 gears are needed for the 5-mesh drive.

In backlash conditions, the planetary system is slightly better than an ordinary gear train. Assuming a 0.002-in. linear backlash in all meshes and 32 diametral pitch, angular backlash is 8 minutes on the output shaft of the gear train, whereas corresponding backlash of the planetary drive is 6 minutes.

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EDITOR'S NOTE: For analysis of the sliding action of involute teeth in standard spur gears, see "How to Predict Efficiency of Gear Trains," Aug 4 '58, p 44.

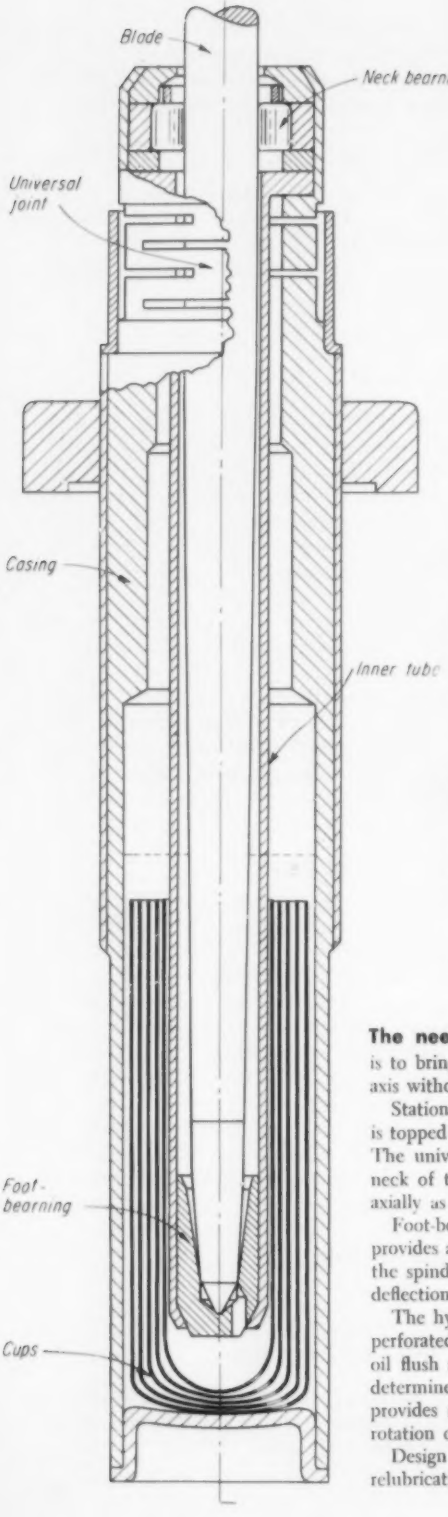
DESIGN FEATURES

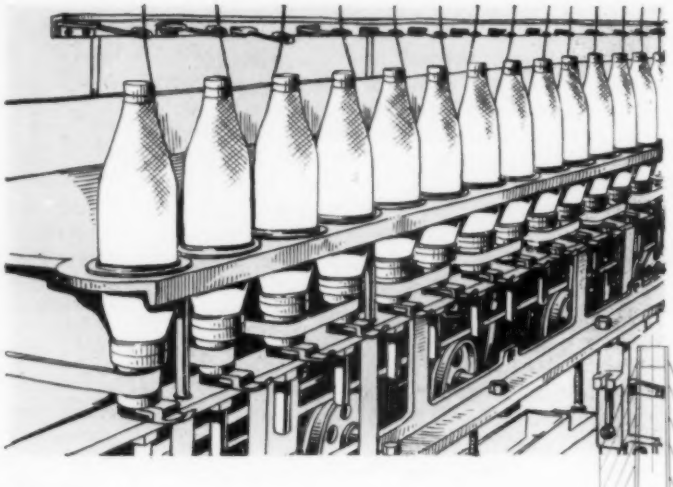
Oilcups Stop Bobbin Wobble

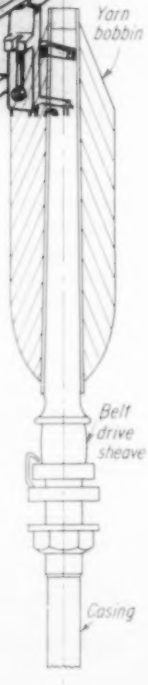
Problem was to keep a high-speed spindle axially in line with its bobbin of unwinding yarn—otherwise, changing centrifugal forces breed vibration and erratic movement.

Answer is a frictionless universal joint with oil acting as a gentle damping medium.

High-speed spindle (up to 18,000 rpm) used in modern mills handles bobbin whose balance is constantly changing. No two bobbins of yarn unwind in precisely the same manner, therefore spindles must be able to compensate for widely varying dynamic loads. These high-speed roller bearing spindles are produced by Spindles, Motors, and Machines Ltd, Ulster, Switzerland.







The need here . . .

is to bring free axis of unbalanced yarn bobbin in line with the spindle axis without generating excessive counterstresses.

Stationary casing of the spindle establishes a precise vertical axis and is topped by a frictionless universal joint supporting the neck-bearing. The universal joint, formed by overlapping horizontal incisions in the steel neck of the casing, is rigid in the radial direction but free to bend axially as required.

Foot-bearing and neck-bearing are connected by an inner tube which provides a rigid bearing-unit that aligns the bearing contact surfaces and the spindle blade. This inner tube transmits all spindle blade deflections to the universal joint through the neck-bearing.

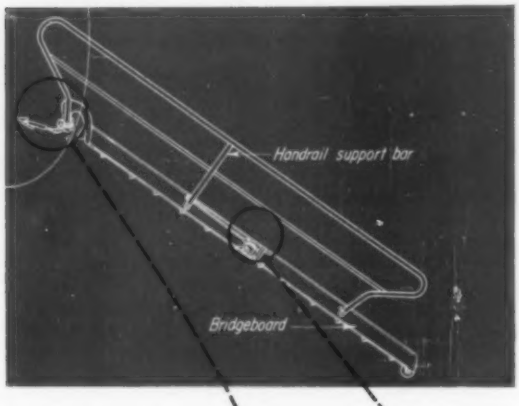
The hydraulic damper consists of five deep-drawn steel cups with perforated bottoms. Specific curvature of the cup bottoms causes a continuous oil flush and provides a hydrodynamic cushioning resistance which is determined by speed of the oscillating inner members. This construction provides an oil cushion around the foot-bearing without impairing rotation of the spindle blade.

Design of casing and tubes permits a complete flushing and relubrication without removing any part other than the blade.

Down to Earth with a 4-Bar Linkage

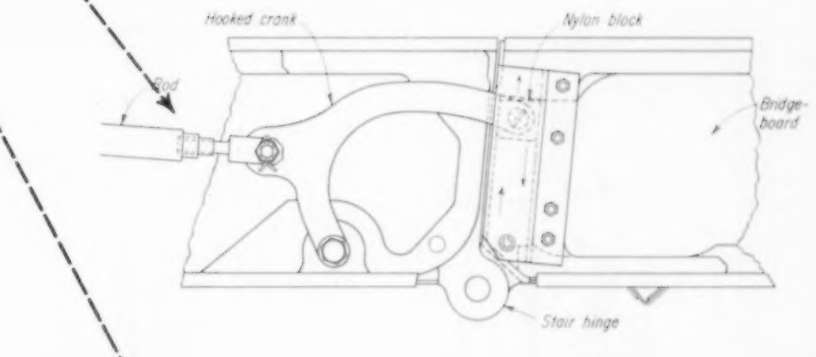
It handles the stairway to an Electra prop-jet. As torque tube unfolds stairs section of the transport plane, torsion bar positions the handrails.

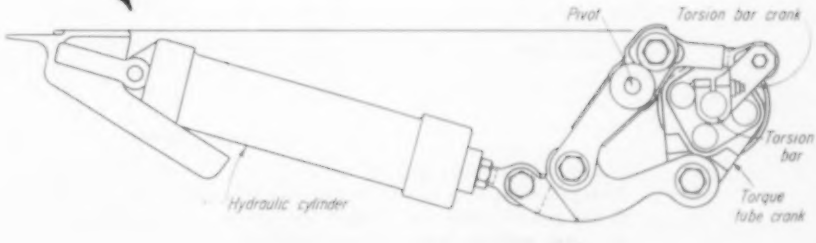
The actual stairway, of aluminum alloy, weighs only 100 lb, but can support a 200-lb person on each step. In emergency, it's pushed out by hand and gravity finishes the job of opening it. Extending 13½ ft from passenger entrance to ground level, stairway folds through 34 x 81-in. opening. Steps have rigidized tread, are individually illuminated by concealed lights. Produced by Lockheed Aircraft, Burbank, Calif.



Hydraulic piston . . . drives the 4-bar differential linkage that operates stairs. Torque tube connects to upper half, rotates 165°; torsion bar attaches to handrail, rotates 85°. Differential linkage movement changes angle of handrail support-bar with respect to the bridgeboard. A crank-and-rod linkage attached to the center handrail support unfolds the stair as it is lowered. The hooked crank pivoted on the upper section has a nylon block mounted on its lower end. This block slides in an aluminum channel on the lower section, causing it to open and close.

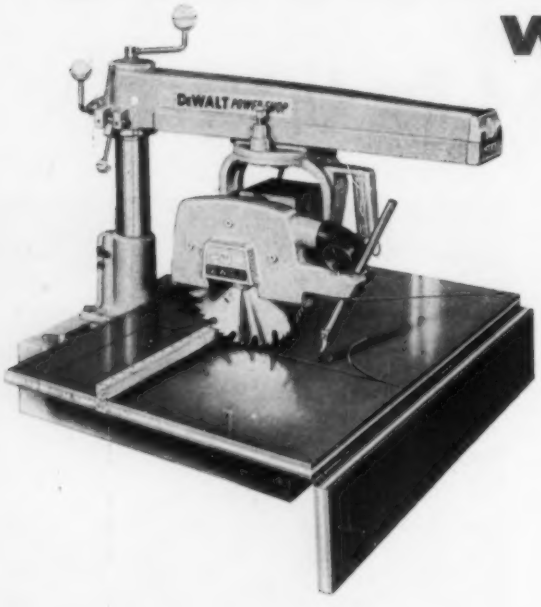
Torsion bars are tempered steel with enough elasticity to let the stairs straighten out for a wide range of ground levels. Limit switches cut off hydraulic oil pressure at the fully raised or 80% lowered position. A throttling orifice in line to the power cylinder allows the stairs to settle to the ground gently after oil pressure is shut off.





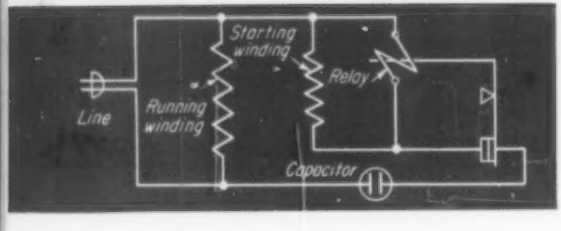
WASTE MOTION

. . . It Brakes Saw



Switch off this power saw and its 3600-rpm blade comes to standstill in five seconds, increasing safety and saving time too. Electrical stage of braking system draws off enough energy from spinning rotor to let mechanical shoe finish the job.

Besides electromechanical brake, the saw features forced cooling of its totally enclosed, dustproof, direct-drive motor; has flat bottom for increased clearance, supplies 2 hp at cutting spindle. Double arbor permits using right-hand drills and routers. Max depth of cut is 2½ in. and saw will rip stock to 24 in. wide. Model 925 Power Shop is made by DeWalt Div, American Machine and Foundry Co, Lancaster, Penna.

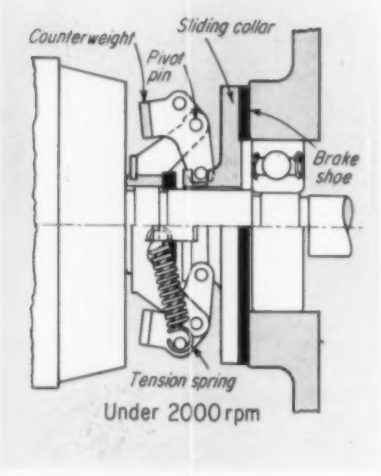


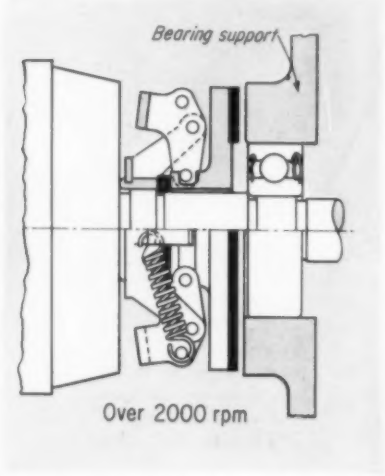
At power shutoff . . .

continued spinning of the rotor generates a voltage in the starting winding. This loads the starting capacitor in conduit box to quickly dissipate the momentum of the rotor. At approximately 1200-1000 rpm, the residual flux and regenerative braking drop off to a negligible value.

Below 1800 rpm, centrifugal force of the counterweights can no longer overcome pressure of the tension springs. They pull the pivoted counterweight inward, forcing the brake shoe against the bearing support and stopping the motor.

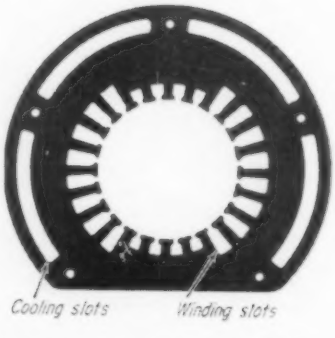
The saw is started with brake applied, but with no other load at this stage the rotor accelerates rapidly and disengages the brake.





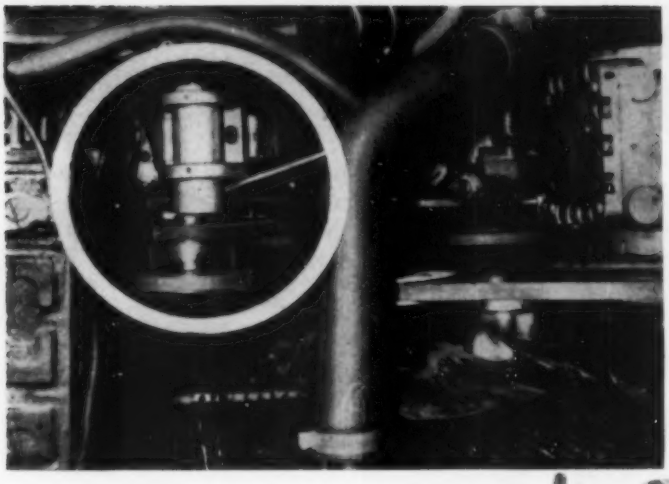
Centrifugal blower . . . ▶

on outer end of motor pulls air in through grille in end-bell. Air passes through cooling slots incorporated in stator laminations and is discharged at saw end of motor. Air passages may be cleaned, by removing fan guard, without altering bearing alignment.



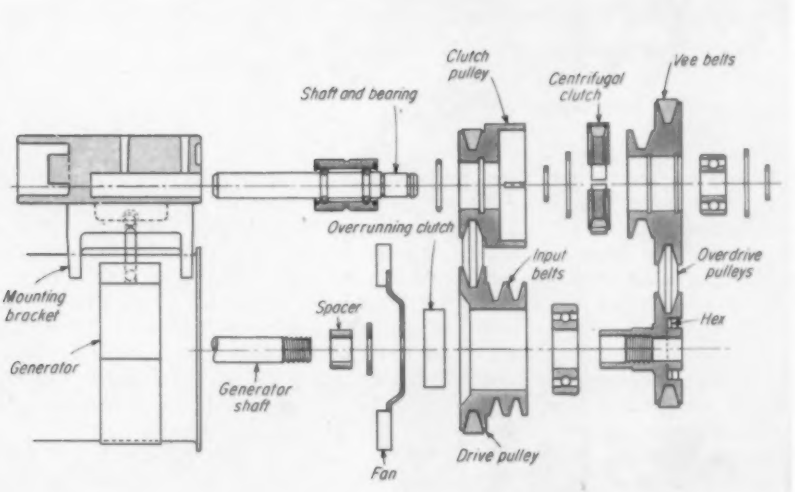
GOES TO WORK

. . . It Speeds Generator



The object here is keeping the battery at high charge. Overdrive unit allows charging it faster at idling engine speeds. Whenever engine speeds up, cutout eliminates overdrive to protect generator from overspeed damage.

Drive unit is used by industrial users who requires maximum electrical power at any engine speed—to operate fork-lift pumps and other special equipment. Photo shows another application: more power for a police car's radiotelephone, air conditioners, blinkers, siren, etc. Less than ¾ hp is required to operate the overdrive; it may be attached to any standard automobile generator. Gen-O-Drive is produced by Consolidated General Products, Houston.



Drive pulley . . .

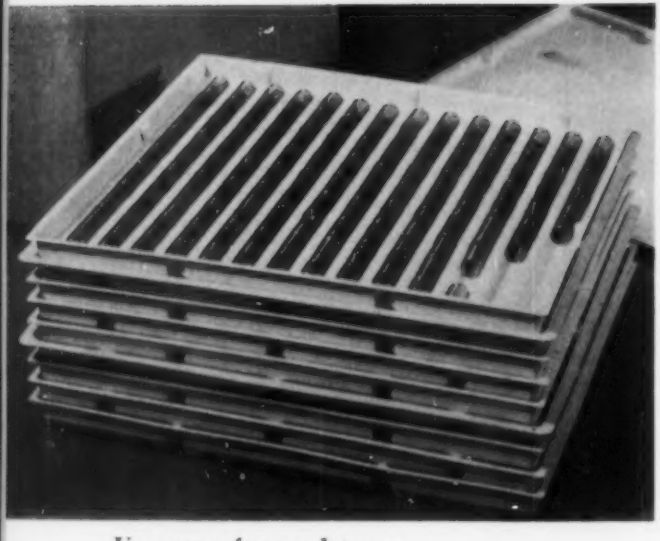
engages V-belt normally used to rotate generator. At speeds above 750 rpm, the spring-loaded centrifugal clutch is disengaged and the generator works off the drive pulley.

Below 750 rpm, springs overcome the centrifugal action of the clutch and engage the overdrive system. Power flow is now from the drive pulley, through the clutch and overdrive pulleys, to the generator shaft. Overrunning clutch permits generator shaft to rotate at higher speeds (4.3:1) than the drive pulley.

Seven pulley sizes and three spacers permit adapting the unit to any automotive generator produced up through 1959. Because bearings are sealed, the only servicing needed is periodic check of belt tension to prevent slippage.

how to lick SPRING TANGLING

Round paper tubes . . .



Vacuum-formed trays . . .

. . . of special form

These packaging methods will keep springs from tangling, protect them from distortion in shipment, and cut assembly costs.

RALPH O JOHNSON, *packaging engineer, Associated Spring Corp, Bristol, Conn*

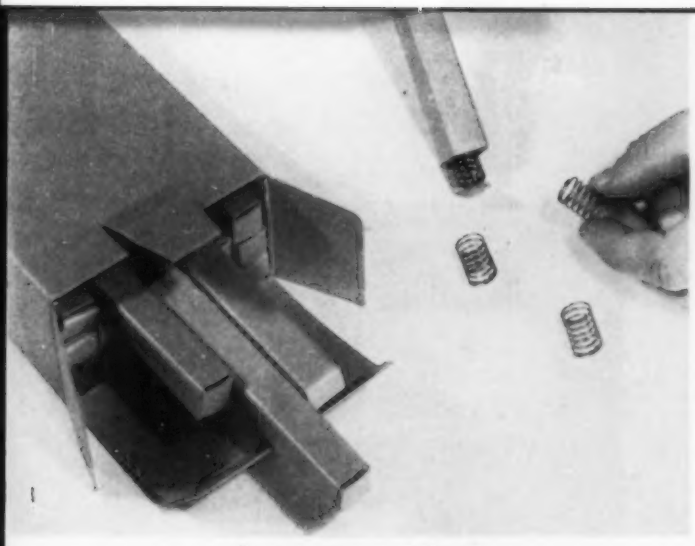
When open-coiled springs become tangled it invariably costs money to undo the mischief. Tangling can be a problem—when the space between coils is greater than the wire diameter—when hooks on extension springs have wide openings—when springs are large and limber. Sometimes redesign can help, but design requirements are often too rigid and result in unavoidable tangling. This is where special packaging methods can prevent foul-up and introduce substantial savings.

Such packaging keeps compression springs from meeting side to side by threading them on paper tubes or dowels, or stacking them end to end in round or square paper containers. "Egg-crate" packages are available in a variety of standard sizes, and are efficient of space. Or the springs may be nested in recesses in vacuum-formed trays; trays themselves may nest for easier shipment.

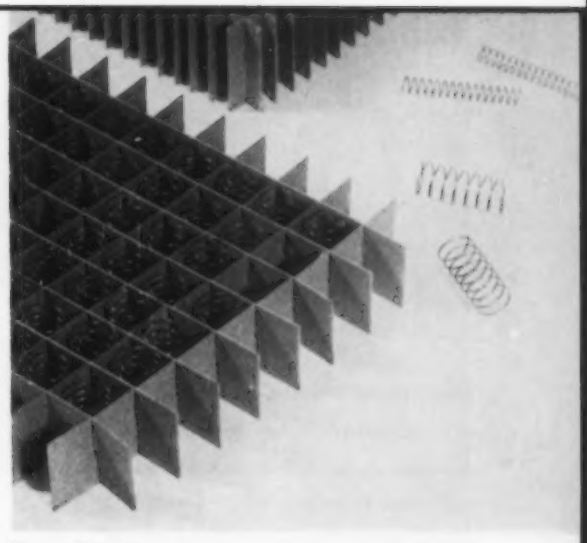
A special form of packaging developed initially for the pharmaceutical field can also prevent tangling. Here, paper corrugations are cemented to a backing strip cut to fold and form a closure for the package. A wide variety of sizes are available, and the method gives good protection to easily distorted springs.

Somewhat similar is corrugated paper with an adhesive coating. It keeps springs in place during shipment and handling, yet permits easy removal without damage. Careful placement is not required, but the packing may give less protection than other methods for springs easily deformed in shipment.

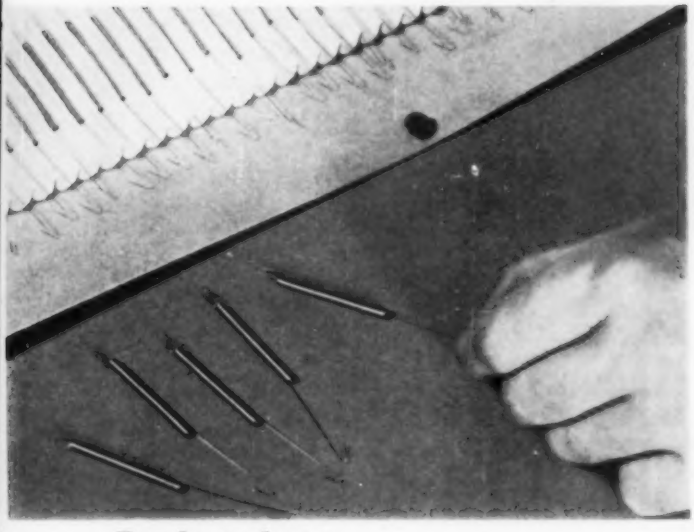
Some types of compression springs can be put on a thread and wound on a reel as they come off the coiler. For use, the operator pulls off 2 or 3 ft, cuts the thread and pulls it out.



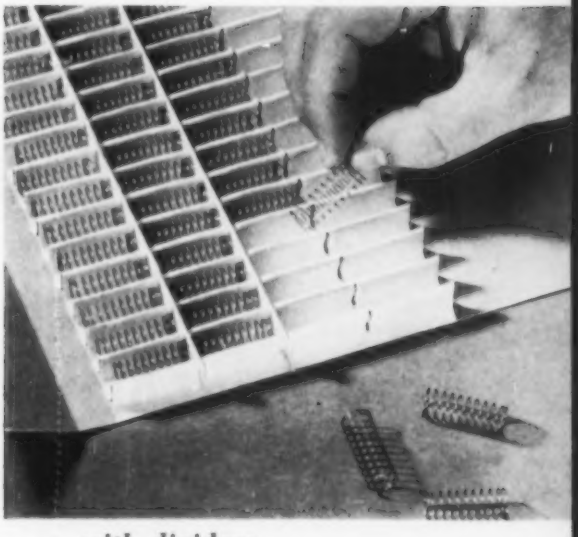
. . . and square containers



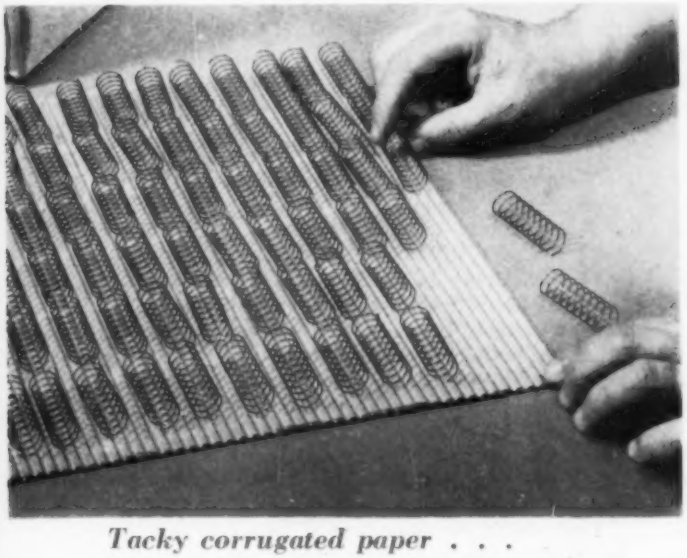
Egg Crates



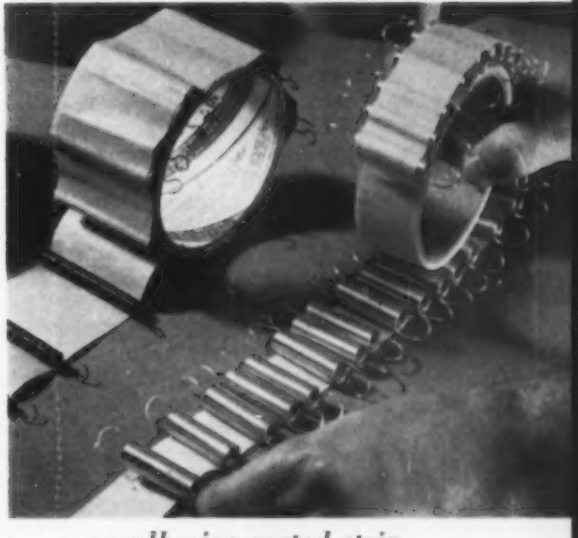
Rondo packages . . .



. . . with dividers



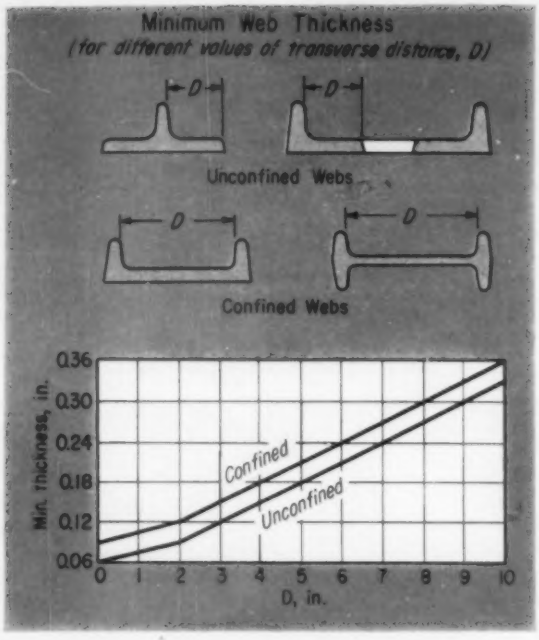
Tacky corrugated paper . . .



. . . or adhesive-coated strip

These parts are now competing with aluminum sand- and die-castings, even with iron castings and steel forgings. Why? Smart design brings out their hidden assets.

D D ERHARD, *superintendent*
E C REBRO, *chief design engineer*
Erie Forging Plant, Kaiser Aluminum & Chemical Corp



WHEN ALUMINUM FORGINGS BECOME PRACTICAL

The drawing board is an important stage in planning a product but tells only part of the story about aluminum forgings. Besides cost of the rough parts, of machining and other manufacturing steps, it should recognize how these parts affect other components in the assembly. For example, an aluminum forging offers consistent high strength with light weight. This can lower inertia losses in reciprocating parts and lower stresses in rotating members. The lighter loads will in turn allow smaller bearings and lighter crankshafts. Because of these and other fringe benefits such as close tolerances and ease of machining, aluminum forgings have become competitive with traditional low-cost parts such as aluminum sand- and die-castings, and cast iron and forged steel.

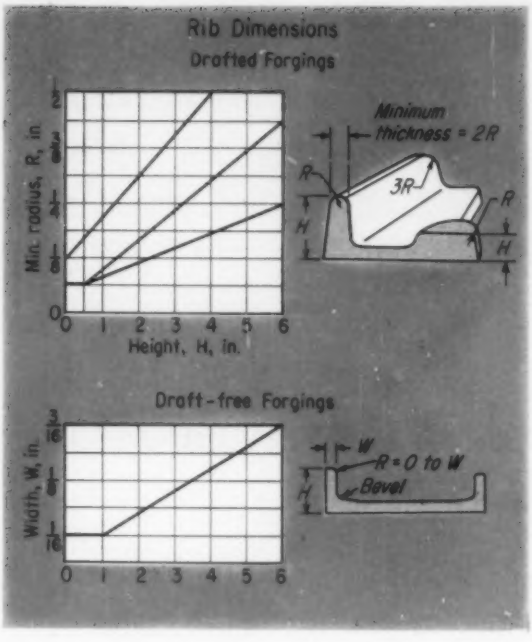
Best design squeezes the most out of the side benefits. It must be close to optimum, yet not so rigid that it will restrict the forging shop from using practical know-how—the kind that determines such important cost factors as forging plane or parting line where dies meet. Because aluminum has its own forging characteristics, basic rules for design are supplied here. (Tolerances, which also affect forgability and ultimate costs, will be considered in the following article.) Furthermore, final shape of the forging should not be fixed until after consulting several sources—each may have different ideas on how to shape for lowest cost.

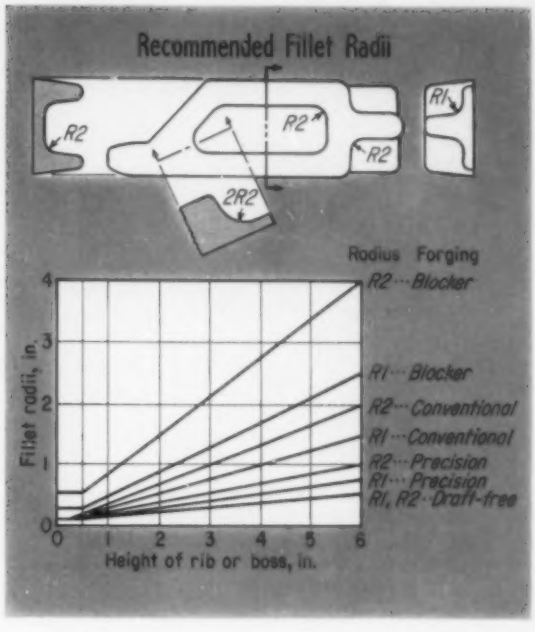
SIGNPOSTS FOR DESIGN

The ground rules for design will help evaluate various proposals and determine final procedure–for example, a closer tolerance or smaller draft in a raw forging will often save many subsequent operations.

Draft angles may be 5 to 7° for forgings made on hammers and 1 to 5° for conventional and precision forgings made on presses. (Draft-free press-forgings can have precision-forging tolerances along with no draft. Their special design is described later in "Draft-free Forgings.") Sometimes, a conventional forging can be tilted in the die so it will get draft from its slanted sides. Here, a simplified example is a square parted across the diagonal. Machining such dies costs more but saves in material and the time to machine it away.

Draft should match or meet at common edges. This lowers die costs, saves setup time, gives better metal





flow, simplifies trimming away flash and detecting mismatch at the parting line. For finish work, it allows more accurate jigging, gives the forging better stress distribution, improves its appearance, and helps make cleaner machining cuts.

Webs, for the best forgings, should be thicker than the minimums given in the chart, and should taper into the flange. A web, usually thinnest portion of the forging, cools first. When it cools below forging range, the entire part must be reheated. Thin webs without tapers would require more forging steps—which shorten die life.

The full story on aluminum forgings has been gathered in *Forging Handbook*, soon to be published by Kaiser Aluminum and Chemical Corp. It carries a wealth of further details, much of it useful shop information such as placement of parting line and forging plane.

Through an exclusive arrangement, PRODUCT ENGINEERING is here presenting, prior to book publication, the first of two articles covering forging know-how of specific interest to design. The next article will concentrate on dimensions and tolerances.

Weight of the forging can be reduced, when needed, by punching out sections of the web. Each punchout concentrates stresses but this can be overcome by forging a bead around the edge of the hole.

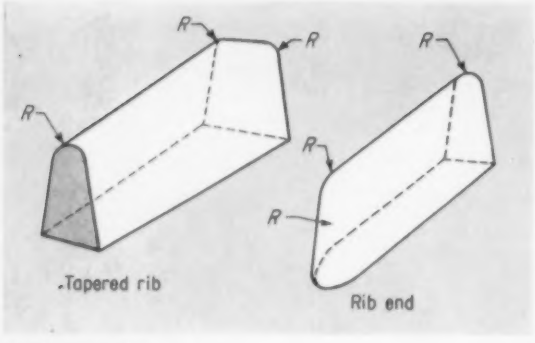
For extra-thin webs, dimensional tolerances in length, width and straightness must be eased to avoid secondary straightening or cold restriking in a separate die.

Parting line and forging plane should be left to the shop. Parting-line location will affect die costs, forging costs, grain-flow characteristics, the number of preform dies, flash removal and, in some instances, the amount of metal to be removed in final machining. Parting line may vary from a simple plane to a complex intersection of several planes or curved surfaces.

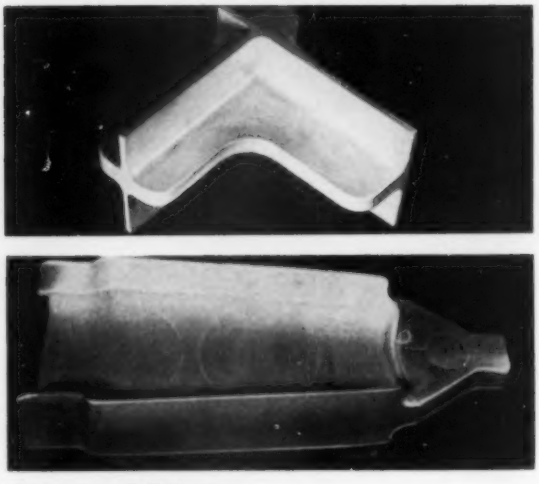
Forging-plane location is critical, particularly when parts are offset in more than one plane. Tilting the forging plane in the die eliminates side thrust and allows lighter die blocks, tighter tolerances for mismatch. Best placement of these comes from experience with the particular shapes, forging alloy, and most of all from type, size and capacity of forging equipment. This is why it may be best to locate parting line and forging plane in different places, and why they shouldn't be located prematurely. The parting line must be shown on the forging print, and over-all dimensions should be given to this point so the trimming die will have to shear through least amount of metal.

In general, centrally located parting lines will need less material to even up draft mismatch. At the other extreme, keeping the impression all in one die lowers die costs. Draft angles must slant away perpendicularly from the forging plane while the draft itself must start at the parting line.

(CONTINUED, NEXT PAGE)



Uniform radii . . .
allow cutting all die fillets with the same tool. At rib end, radius becomes larger to follow profile of the tool.



These aircraft fittings . . .
have no draft, show that impact-extrusion process has graduated from making cans and toothpaste tubes.

Corner radii on external corners should be kept uniform throughout a forging. Dies are cut with round-nosed tapered cutters, and the nose cuts the fillets. Therefore, uniform radii at corners will allow them to be made from the same cutting tool. The sides of the cutter are tapered at the sides for draft, and radii in this dimension increase with width of cut. Allowing these larger radii at rib ends gives better metal flow and avoids trapping gas in this area.

Fillet radii or internal corners on a forging, unless they are large enough, will hinder smooth flow and cause laps and cold shuts. Metal in general flows away from the applied pressures—most noticeable in hammer forgings. Recommended radii for lowest forging costs and optimum die costs are given on the previous page.

Small radii which are below the recommended can be forged by first preforging the blank in a blocker impression built into the same die. This distributes the metal into place before the final finishing die is used. In extreme cases, small fillet radii dictate a preblocker die.

DESIGNING DRAFT-FREE FORGINGS

Draft-free forgings are hybrids of forgings and extrusions (*PE—"Aluminum Impact Extrusions," Nov 25 '57, p 72*) and need different design concepts. Because the method can combine thin sidewalls with heavy bottoms, intricate bottom designs, irregular cross sections, walls with varying thicknesses, and longitudinal ribs, it often substitutes a one-piece part for an otherwise intricate assembly.

Because these forgings must be ejected from the die, part shape must be rigid enough to withstand forces from ejection pins, else there would be excessive distortion. In many cases, no-draft forgings can allow major reductions in subsequent machining, assembling and finishing operations.

Design is special here because the extruded metal cannot be turned as it is forced out of the die cavity. This forces sidewalls to remain perpendicular to the bottom, i.e. draft-free forgings. Rounding of the outer edge is essential—edge and corner radii should have a minimum of $\frac{1}{8}$ in. But unlike conventional forgings, excessively large radii are not helpful—and increase friction between punch and die.

Ideally, shell or wall length should be about six times the inside diameter. Actually, length of extruded shell is limited only by column strength of the punch. In some cases length has been as high as 20 times' diameter. Symmetrical sidewalls allow deeper parts because of less side forces tending to buckle the column. The balanced metal flow also gives more uniform properties and more uniform wall thickness. A small 15° bevel around the edge of the punch will also help it stay centered.

For best designs of no-draft forgings, avoid excessive pressure on the tools. It lowers concentricity of interior to exterior dimension of the wall. Keep peripheral area of the part to a minimum; for example, a round shape would need less extruding pressure than a square of same area. Avoid excessively thin walls; they also require more working pressure.

Choose easy-to-extrude alloys like 1100 aluminum; for greater strength, 6061 and 6151; and for even greater strength, 2014 and 7075. The latter, however, require heavier wall thickness.

EDITOR'S NOTE: For additional information on designing strong lightweight parts from aluminum alloys, see:

"Forging Presses Strength into Lightweight Castings," Feb 16 '59, p 61—gives data on hybrid technique that improves aluminum and magnesium castings with followup forging.

"Those Heavy Presses Can Pay Off," Sept 29 '58, p 34—describes 5 new process areas for heavy presses that deliver a squeeze measured in kilotons.

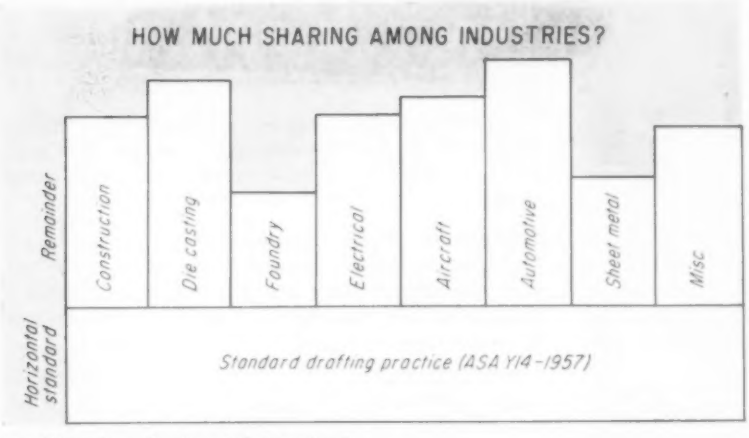
"High-integrity Aluminum Castings," Feb 17 '58, p 69—advises choosing the proper alloy, designating requirements of critical areas, corroborating foundry practice with test data.

"New Aluminum Forging Alloy," Dec 25 '57, p 62—introduces 7079, a composition with lower notch sensitivity than alloy 7075 for thick-section applications requiring high strength.

MORE ROOM for COMMON STANDARDS

Nonstandard practices cause endless confusion.
Why, then, deny recognition
of practices already common to small segments of industry?

KENNETH M STOLL, *equipment standards coordinator, Sylvania Electric Products Inc*



Drafting is a horizontal standard . . .
that reaches into all industries—but covers only a fraction of practices in each. Proposed "area standard" would gather together those of the remaining drafting practices which have proven worth.

The plain fact of the matter is: Standards save money and eliminate confusion–they have no other reason to exist. A practice is developed in an industry because it cuts costs in some way.

But to be effective, standards must be dynamic. If they cannot attempt to **force** industrial progress, neither dare they **lag** behind. This is why another category, the "area standard," is necessary.

Already we have two common groupings of standards: vertical and horizontal. **Vertical standards** control activities which are closely similar. Examples are standards for textile test methods, for electrical machine brushes, for copper pipe, for circuit breakers . . . and thousands of other group needs.

But dissimilar industries are becoming increasingly interdependent. This forces the writing of standards that cut across industrial lines. Hence the **horizontal standards**, such as those established for drafting practice. They are valuable in areas where one industry has to know and understand the practices of the other.

But the horizontal standard is only partially effective, even in its most ideal condition. Different industries have certain totally different practices. A horizontal standard is only a compilation of those practices common to all–usually quite a small number.

The standards for drafting practices well illustrate such limitations. Even the most conservative estimate of the amount of common drafting practices is bound to be small. In every industry there is a large remainder not covered by the horizontal standard. Obviously, therefore, vertical and horizontal standards must be supplemented with some concept of area standardizing. The losses to our economy for lack of such a program cannot be justified.

A Standard for Nonstandards

An **area standard**, then, would be a full-scale "dictionary" of all those practices of demonstrated worth which cannot win majority acceptance. If effectiveness of the practice has been shown in any one group, it could be offered for trial by all groups. And if it were to be encountered anywhere by any group, means for understanding and interpreting it would be available.

Simplified drafting methods, for example, have been well received, with substantial savings realized in nearly every case. They were not, however, granted inclusion in the new Y14 Drafting Practices of the ASA. This is understandable–until simplified techniques can merit majority approval they should not be a part of the horizontal standard. But, if an area standard were available–and it is sorely needed–all simplified drafting methods of proven value, as well as other "nonstandard" drafting practices, would be available for consideration and trial.

Another important function would be served by area standards–as "proving grounds" for resolving differences wherever horizontal standards have not yet been created, but perhaps should be.

Such dictionaries of practice are not entirely an innovation. For example, makers of such unlike products as machine-tool control components, motors, transformers, and appliances have each developed terminal markings to their own liking. These are a part of their individual vertical standards. Workmen who install or service installations where the several practices are encountered need to know the interpretation of each. In this particular case, a horizontal standard has not yet been developed–but an area standard has. The standard (ASA C6.1-1956 Terminal Markings for Electrical Apparatus) is a dictionary of all the many terminal marking practices. Let's have more such "dictionaries."

EDITOR'S NOTE: For other viewpoints on the setting of standards, see "Legal Aspects of Standardization," Dec '55, p 162; "Problems of Standardization Programs," Nov '55, p 178; and "Drafting Procedures Should Be Standardized," Aug '55, p 162.

to meet the need—Better Ratings for

The rating problems faced by the industry are many and complex. But they can be simplified, says the author. He's chairman of the special valve-rating committee, National Fluid Power Association (NFPA).

JOHN J PIPPENGER, *chief engineer*
Hydraulics Div, Brown and Sharpe Mfg Co
(and v-p of its subsidiary, Double A Products Co)

A single, universal rating sheet for fluid-control valves—if such a thing were practical or even possible—would need spaces for over 800 entries. After all, there are at least two dozen valve types in the fields of pneumatics and hydraulics, and several dozen important functions and limits for each.

But the problem is now being attacked logically by NFPA. From preliminary meetings of the special valve-rating committee, this much can be predicted: an effort will be made to bring orderliness to specifications and catalogs. The systematic approach suggested in this article shows the type of information a product designer must get before he can judge available valve designs. Such data should be consistent, based on tests standard for all manufacturers.

However, a single rating in each category is not enough; supplementary data, curves and qualifying statements are often essential. Also, don't count on any more adjustment range than the valve rating specifies. If margin is wanted in a circuit, pick a valve with a wider rating; but remember that adjustment accuracy is lessened as range increases.

These examples explain why ratings are rarely simple:

- The pilot chamber in some compensated reducing valves cannot withstand as high a pressure as the main chamber can.
- Flow and pressure drop for a 4-way directional valve will probably differ with each variation of spool position, flow direction and porting arrangement.
- Minimum controllable flow rate of a flow-control valve is affected by pressure level.
- A flow-control valve with free reverse flow will have different ratings in each direction.
- A flow or directional valve depends on the pressure drop to pass fluid, but it is the external circuit that limits the allowable drop.

1—PRESSURE

Pressure directly or indirectly influences most other ratings including flow, response, duty cycle, and life.

Bursting pressure, expressed directly or as a ratio of the maximum normal pressure, is a clue to the safety margin. In the event of circuit over-pressure, caused by falling, uncontrolled or intensified loads, or by maladjustment of the valve mechanism, it is important to know ultimate limit as well as recommended one. The ratio of bursting to max normal pressure can be from 2 to 10, but is usually 3 to 5.

These other important levels of pressure occur in actual operation:

Maximum safe surge pressure generally applies to the housing, can be as high as 75% of bursting pressure. A **safe continuous pressure** will be less. It is recommended that the safe continuous value be marked clearly on the housing, next to max adjustable pressure.

Maximum normal pressure—a recommended limit—will pay off in longer life and reduced leakage. Line pressure is usually kept at or below max normal-pressure rating of the valve.

Maximum adjustable-pressure rating is usually lower than normal pressure because a surplus is needed to make the valve function smoothly and positively. **Minimum adjustable pressure** is the lowest normal setting. For any setting, some fluid flow is usually needed.

Other adjustments, higher or lower than rated, can be made under certain circumstances with approval of the manufacturer. Some valves will withstand higher pressures if the parts are kept moving slowly, but excessive speed of reciprocation may cause shock pressures. "Relaxing" a biasing spring, removing it altogether, or draining the pilot chamber can lower the rated minimum setting—often at expense of adjustment and smoothness.

This hypothetical valve shows a typical relationship between all pressure levels (psi): bursting, 16,000; max safe surge, 12,000; max safe continuous, 5000; max normal, 3000; max adjustable, 2000; min adjustable, 300; min with all adjustments relaxed or drained, 50. It is assumed that the surge duration is no more than 20 milliseconds. If double precautions are needed, then a hydraulic fuse, set for 12,000 psi, will dump pressure in much less time.

2—FLOW

Flow rating, like pressure rating, can be defined at many levels of performance.

Ultimate maximum flow occurs with the valve wide-open, fluid at high temperature, supply pressure at highest safe value, and downstream pressure at zero. This rating may suffice for relief valves and other components that must dump a circuit quickly, but the more general conditions must be remembered for complete specifications.

Maximum normal flow is developed when supply pressure is at max normal value, and valve is operating

FLUID-CONTROL VALVES

wide-open in a normal circuit. An adjustable valve, for example, would be at extreme end of adjustment.

Maximum and minimum adjustable flows recommended are those that are essentially accurate and repeatable without adjustment difficulties. They don't necessarily include flows at the extreme ends of the adjustment.

Fluid-temperature variations will affect flow in valves that are not compensated in some way. Therefore a statement, equation or chart should accompany the valve to help predict these changes in accuracy—particularly when a dial is used—unless the changes are considered unimportant.

Nonadjustable flows can be measured in terms of pressure drop across each pair of ports for various given conditions of flow, viscosity, and total pressure. The combinations are practically infinite, so only representative values can be given.

In rating actual valves, it is common to select an oil at some normal viscosity—say, 150 SSU—then plot pressure drop in psi vs flow in gpm. Pressure drop will increase roughly as square of the flow. Vickers Inc plans to use a JIC valve symbol to carry pressure-drop information on valve drawings (*PE*—May 11 '59, p 27). For more flow information, refer to a good catalog such as "Flow of Fluids—Technical Paper No. 410," available from Crane Co, 836 S Michigan Ave, Chicago.

An alternate flow-rating method is to provide a so-called "flow factor" that gives pressure drop when multiplied by flow or some function of flow. A summary of such factors—and there are many different ones—is found in these past articles—"Pressure Drops in Air Valves," Apr 14 '58, p 74; "Pressure-drop Calculations," June '54, p 197; and in some catalogs.

Don't rate flow by pipe size at the connection; better supply equivalent orifice diameter of the valve if actual performance data cannot be given. In adjustable-orifice types that don't close completely, also give equivalent opening at closure.

Leakage flows are important for two main reasons. If external, loss of oil from the system is troublesome. If internal, performance of the valve might suffer—a difficult fault to check. Both affect circuit calculations.

Clearance flow, a normal function, will affect performance in a uniform and predictable manner.

3—RESPONSE

Speed of response depends on: inertia, cross-section area and displaced volume of the spool; fluid viscosity; supply pressure available; stored spring energy; solenoid power (if used); and flow restrictions. Pressure levels can also affect timing by deforming external piping and other chambers—thereby changing decompression time.

(TEXT CONTINUED ON PAGE 82)

8 Checking Areas When Rating Valves

1. PRESSURE
- Bursting
- Max safe:
  - surge
  - continuous
- Max normal
- Adjustable:
  - max
  - min
  - other

2. FLOW
- Max:
  - ultimate
  - normal
- Adjustable:
  - max
  - min
- Non-adjustable:
  - pressure vs flow
- Leakage
- Clearance

3. RESPONSE
- Speed:
  - starting
  - opening
  - closing
  - cycling
  - damping
  - adjustment
- Sensitivity
- Stability
- Repeatability

4. DUTY
- Load:
  - steady
  - intermittent
  - heavy
  - light
- Fluid:
  - type
  - temp
  - contaminants

5. ENVIRONMENT
- Vibration
- Shock:
  - mechanical
  - thermal
- Temperature
- Corrosion
- Humidity

6. DESIGN
- Spool:
  - clearance
  - overlap
- Passages:
  - internal
  - external
- Efficiency

7. LIFE
- Seals
- Spools
- Insulation
- Solenoids
- Springs

8. STANDARDS
- JIC
- NEMA
- UL
- Military

TYPES OF CONTROL VALVES

Pressure	Max (relief, safety, fuse)
	Min (sequence, counterbalance, unloading)
	Reducing (simple, integral-check)
Flow	Check (simple, return-orifice, decompression)
	Flow-control (fixed and variable orifice, free-return)
Directional	Power (2, 3 and 4-way)
	Logic (momentary, shuttle, pilot)

Note—Valves may also be: piloted or unpiloted; compensated or uncompensated; damped or undamped; solenoid, fluid, or manually operated

Time interval from signal to initial movement (**starting**) is different from **opening** time (full movement of spool). And **closing** time may be different than both. **Cycling** speed is not simply the sum of opening and closing, but also depends on reversing ability of piloting system and on resonant frequency of circuit.

A typical relief valve must open quickly but closing should be slower, to prevent oscillations and subsequent shock loadings. Actual performance shows opening times are quick enough to limit overpressures to less than 1% of rated or set pressure because less than 0.001-in. spool movement will partially open the valve. A reclosing time of about 50 millisec may be considered standard, but by altering the orificing that lets the fluid back into the control chamber, time intervals from less than 5 to over 500 millisec are usually possible.

A reducing valve is reverse of a relief valve; it closes fast, reopens slowly, depending on the amount of pressure shock tolerable in the downstream circuit.

Valve speed can be decreased—sometimes necessary for **damping** or circuit timing—with internal or external needle valves, adjustable orifices and other controlled restrictions. **Speed adjustments** should be rated in increments of time such as milliseconds so that response can be checked with electronic instruments and calculated as well.

Sensitivity, stability and **repeatability** depend on valve design and should be assigned values where applicable. For example, give signal values (electrical, mechanical, hydraulic or pneumatic) needed to operate a loaded valve.

4—DUTY; and 5—ENVIRONMENT

"Duty" describes the type of service a valve is used for. Pattern, frequency and severity of the **load; fluid** type, its temperature and degree of contamination; and physical **environment**—all these are part of duty.

6—DESIGN

Pertinent design features should be included in ratings for some valves. Functional diagrams, such as JIC symbols, show *what* the valve does, but information on *how* it works is useful too.

Knowledge of **spool** diametral **clearance** will help predict effects of thermal shock or dirty oil, and perhaps avoid later "seizing" or "pressure freeze" in the valve. Losses through integral clearances can help lubricate and flush the valve. Amount of valve overlap between ports while the spool is moving is important in design of some circuits.

Longer or more restricted **passages**, internal or external, such as hollow spools and cramped fittings, will increase pressure losses. A detailed porting diagram is sometimes helpful. It can show, for example, whether pilot drains are integral with the main tank port or completely separate—invaluable in calculating response times under unusual conditions such as high back pressure at tank. Estimates of over-all **valve efficiency** help predict power losses in a fluid circuit.

Limitations should be spelled out. For example, explain whether physical stops establish maximum and minimum adjustments. And give tips for mounting and connecting valve. In general, tapered-thread connections should be satisfactory up to 1000 psi; straight threads are good for over 3000; and flanged or base-plate valves are limited in pressure only by the hold-down forces, seals and valve materials.

7—LIFE

Life of the valve is affected by all other factors, so is hardest to predict. Perhaps the answer is to first agree on a standard life test, then rate the valves accordingly. ASTM (American Society for Testing Materials) is now preparing a list of test fluids. Estimates of compatibility and life should be possible for **seals, spools** and **insulation,** based on given fluids, pressures, dirt particle size, temperatures, and types of contamination. A seal may wear longer if designed to operate at drain pressure rather than at maximum pressure. It has already been proven that life of a **solenoid** increases immeasurably when it is sealed in oil. **Spring** life can be predicted if the temperature and load cycle are known.

8—STANDARDS

Standards applicable to each valve should be listed with other valve-rating information. It might help to point out the main requirements of each standard as it applies to the valve in question.

For REPRINT of above article, just check E87 on one of the Reader Service cards bound in this issue.

EDITOR'S NOTE: A survey of all hydraulic control valves—how they work, how they are used in circuits—is given in this previous series of five articles by the author: "Relief Valves," Dec '56, p 174; "Pressure-control Valves," Jan '57, p 196; "Flow-control Valves," Mar '57, p 144; "Directional Valves," May '57, p 167; and "Valve Circuits," July '57, p 197. The book *Fluid-power Controls* is based on these articles, and available from McGraw-Hill Book Co.

Design and operation of both pneumatic and hydraulic valves is covered in these articles: "Valve with a Memory," May 26 '58, p 76, describes valve that applies logic to pneumatic control; "Calculating Time Lag of Hydraulic and Pneumatic Valves," June '56, p 158, gives formulas and curves; and "Solenoid Valves for Fluid Directional Control," July '55, p 162, discusses 2-, 3- and 4-way oil and air valves.

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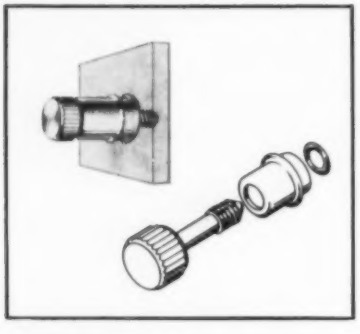
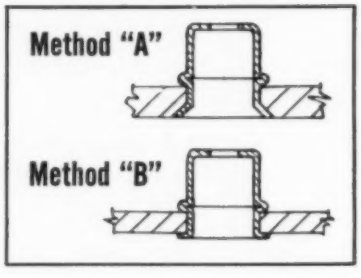
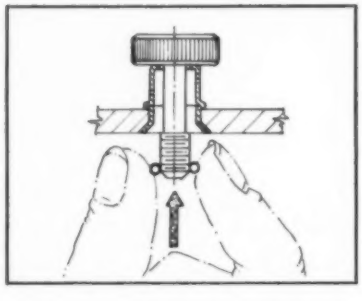


shown below, meet a very wide variety of requirements.

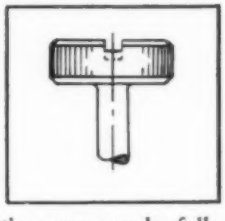
Check these advantages of simplified Southco Captive Panel Screws. Even when many screws are in one panel, misalignment is easily handled because the screw floats in a large hole in the stand-off, allowing ample play for "lining up." No special tools are



needed for installation, thus production is not subject to tool failure, nor limited by either the number of special tools available or the number of personnel trained in their use.



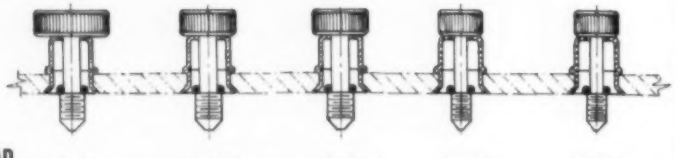
The Southco No. 58 Retractable Screw Fastener consists of three parts: thumb screw, stand-off, and retaining ring. The bright nickel-plated brass stand-off is inserted in either a drilled and countersunk hole (Method A), or a drilled hole (Method B), and flared. The polished, chrome-finished brass screw is passed through the hole in the stand-off and made captive by a retaining ring. Engaging in a tapped hole



in the frame, the screw may be fully withdrawn without moving the panel, yet always is retained.

The unslotted screw is standard in $\frac{3}{4}$", $\frac{9}{16}$", and $\frac{7}{16}$" head diameters and three thread sizes. Slotted head screws are also available in all sizes. The stand-off is standard in sizes to fit panel thicknesses from a minimum of $\frac{1}{16}$" to a maximum of $\frac{17}{64}$". Screw and stand-off are also obtainable in stainless steel.

MINIATURE TO LARGE SIZE HEADS IN FIVE TYPES



HEAD DIAMETER	3/4"	9/16"	9/16"	7/16"	7/16"
THREAD SIZE	1/4-20	1/4-20	12-24	10-24	10-32

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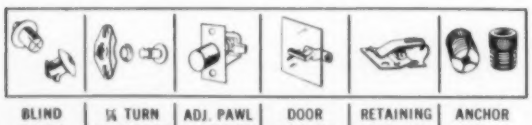

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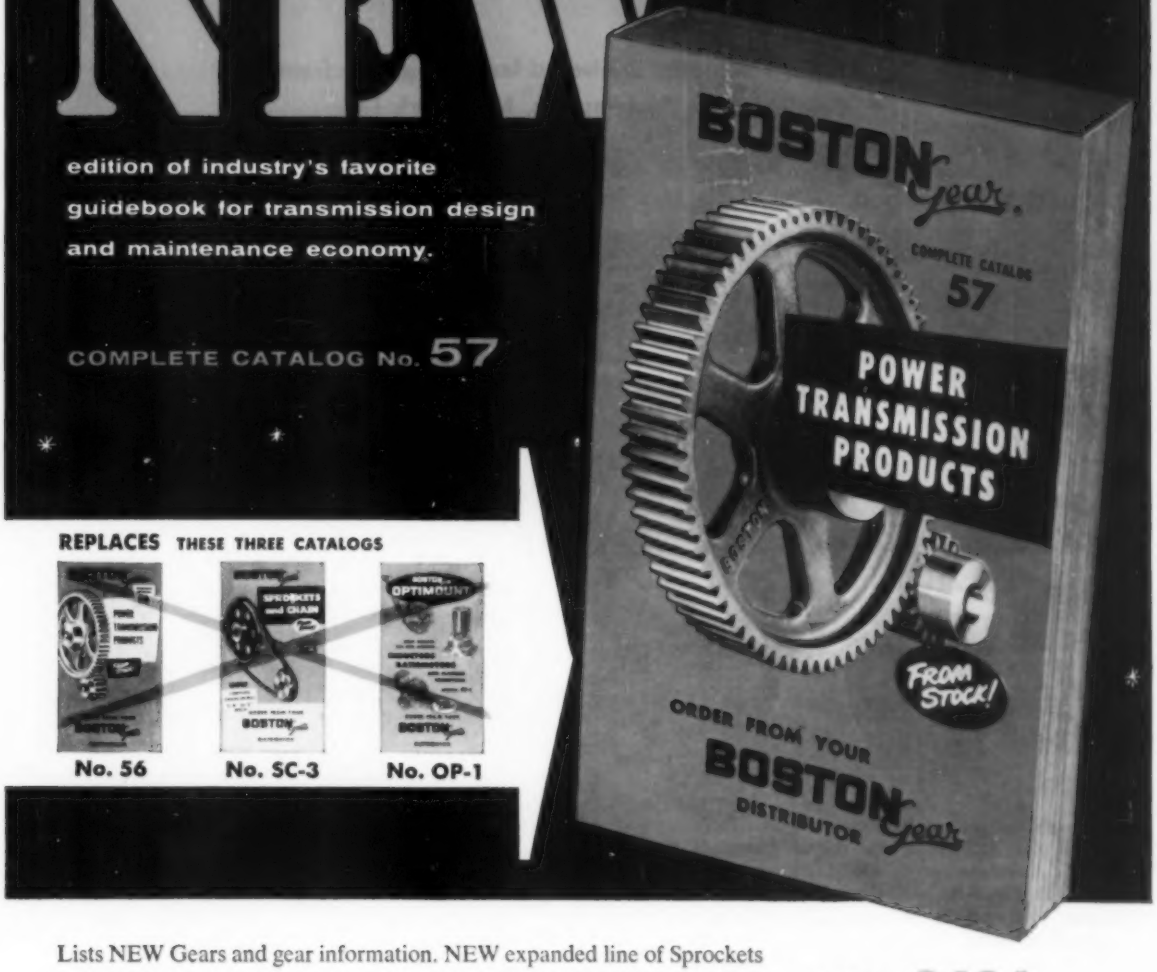

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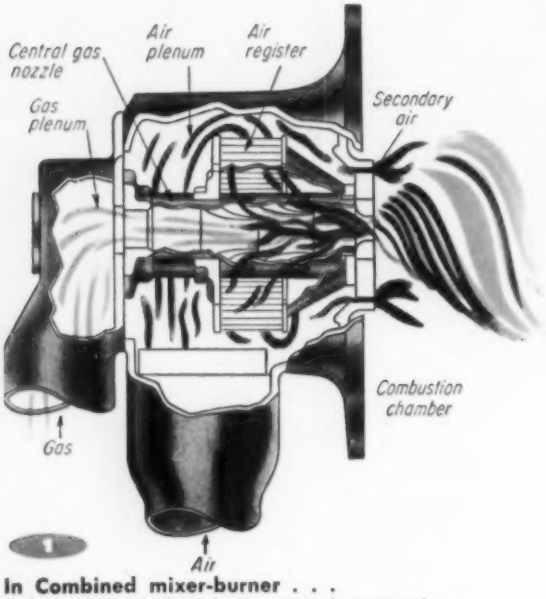
6 MIXERS for Burner Gas and Air

These schematics are based largely on data from Columbia Gas Systems, Inc, New York 17.

DOUGLAS C GREENWOOD, *associate editor*



1

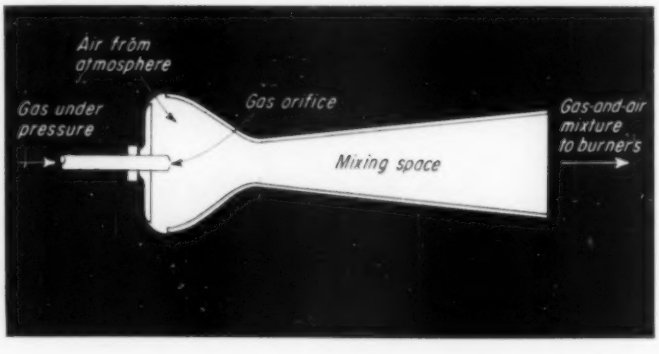
In Combined mixer-burner . . .
fuel-gas flow is through the central gas-nozzle assembly from the gas plenum. Simultaneously, combustion air from a blower enters the air plenum, automatically controlled by a motor-operated air valve. Primary premixing air is captured by the stationary air register. This assembly directs the premixing air through holes into the gas-nozzle assembly. An outer secondary air ring controls the proportion of secondary combustion air admitted to the combustion chamber.

Once properly adjusted, each of these mixers will constantly maintain the desired ratio of air to gas over its entire operating range. All 6 are so designed that automatic valves can be added to control and maintain the desired processing temperature.

Gas, as it is delivered, is in a condition for immediate combustion. This simplifies gas-burner equipment, allows it to be made in a wide range of sizes—from tiny dental torches to huge burners on glass-melting tanks.

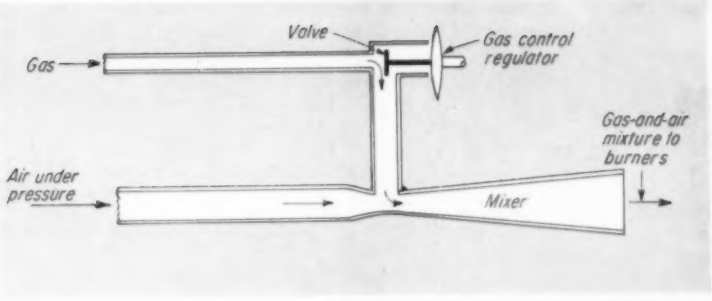
Stability is an important requirement of burners. A stable burner is one that will maintain ignition when cold, and at the pressures and ratios ordinarily used. (No burner is considered stable merely because it is equipped with a pilot.)

Many burners will work satisfactorily under adverse conditions (particularly cold surroundings) only if the mixture is rich and if the flame is burning in free air. With burners so adjusted it is necessary to leave the furnace doors open during the starting period. If the doors are not left open, the free air in the furnace will be used up after a few seconds' operation, and an unstable burner flame will be extinguished. It is under these conditions that the presence of a pilot may be a potential source of danger, because combustible gases will collect quickly after the flame has been extinguished and may be ignited explosively by the pilot.

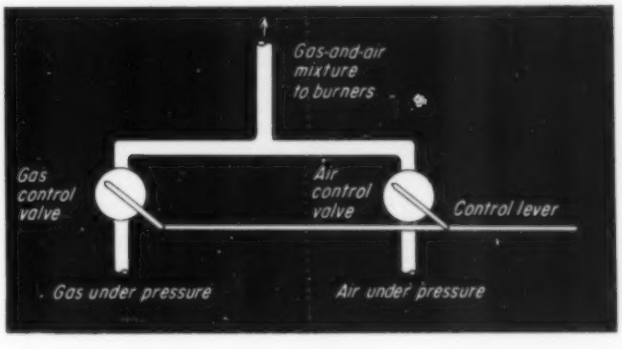


2

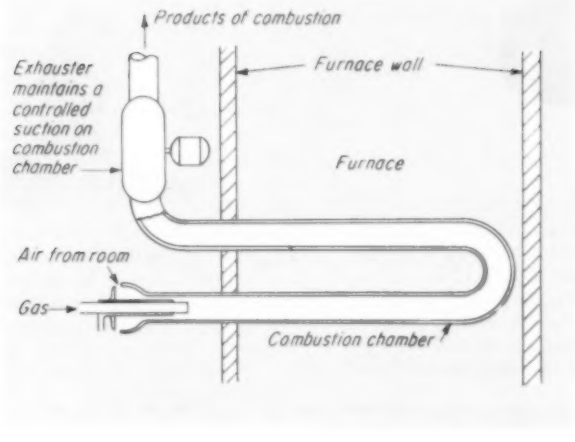
High-pressure gas . . .
passes through the orifice under sufficient pressure to create enough suction to entrain all the air required for combustion from the surrounding atmosphere. This class of equipment requires gas pressures from 10 to 20-psi gage.



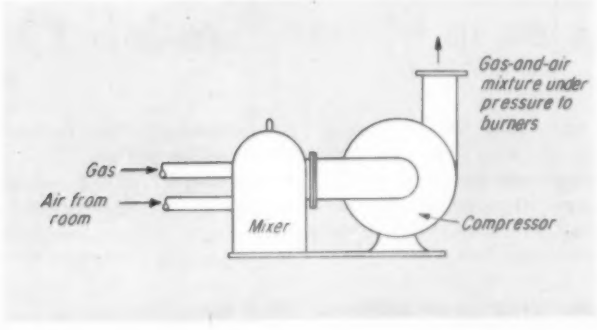
Low-pressure air . . .
in a suitably designed mixer can create enough suction to entrain all the gas required for combustion. This class of equipment generally uses air at pressures from 1 to 2 psi, and gas at about ¼ psi.



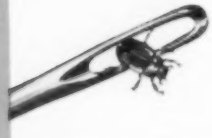
Two-valve mixer . . .
uses gas and air under approximately the same pressures, each passing through its own control valve. The two valves are so sized and positively interlocked that any movement of one causes a corresponding movement of the other.



Suction . . .
is so regulated that its action on the combustion chamber draws in just the right amount of gas and air.



Mechanical mixer . . .
is much the same as a small compressor—so designed that it will pull in the proper amounts of gas and air, mix them thoroughly, and deliver the mixture under pressure to the point of combustion.



Smallest of the Small. A pigmy beetle could easily crawl through the eye of an ordinary sewing needle, as shown by this equally magnified view of both. Among the tiniest of insects, some species of pigmy beetles reach about one-hundredth of an inch in length.

Miniature for Missiles. This tape recorder, shown one-sixth actual size, is a vital unit in the communications system of the Army's "talking satellite." Constant low-torque and quiet operation of MPB bearings in it maintain accurate tape position.

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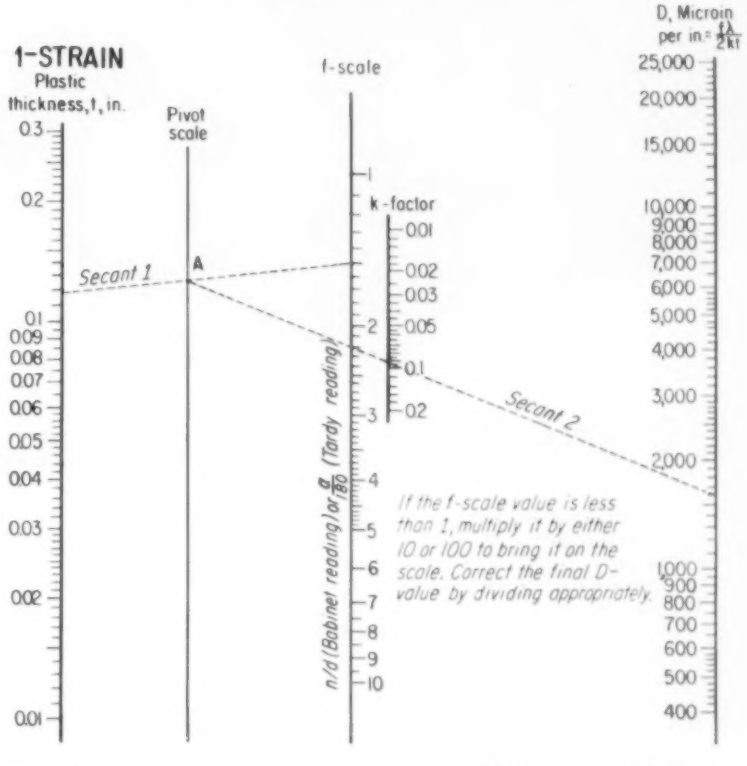
SYMBOLS

f = "fringe value" (instrument reading divided by instrument constant)
δ = optical retardation $= f\lambda$
ϵ_1, ϵ_2 = principal strains
σ_1, σ_2 = principal stresses
λ = wavelength corresponding to tint of passage $= 2.27 \times 10^{-5}$ in.
D = difference of principal strains
d = compensator constant (Babinet)
α = rotation angle as measured by Tardy compensator
n = difference of Babinet compensator readings between strained and unstrained state
k = factor for plastic (supplied by maker)
t = thickness of plastic
E = elastic modulus of structure material

PhotoStress technique allows actual structures—rather than transparent-plastic models—to be stress-analyzed while they are under load. Ordinarily, readings from the polariscope must be worked into formulas. The nomographs presented here, however, give stress and strain answers direct from the instrument readings.

Otherwise, the technique remains the same. A thin coating of special double-refracting plastic, cemented to the actual part, will follow every surface strain. The plastic acts like an infinite number of tiny strain gages. When viewed through a polariscope, color patterns become visible. These can be interpreted, in terms of surface strains in microin, and of stress in psi. The polariscope is fitted with either a Babinet or a Tardy optical-compensator, which is adjusted to match colors or "fringes." The instrument measures the amount of adjustment and these are the readings that can be fed to the nomographs.

Nomograph 1 may be used to find either max shear strain or the difference between the principal strains. Nomograph 2 gives the individual values of principal strains ϵ_1, ϵ_2 and stresses σ_1, σ_2.



Example 1

If only the strain difference is required, the part may be viewed with "normal incidence" light only—the light path will be perpendicular to the plane of the plastic coating. Assume $t = 0.118$ in., $k = 0.09$ and $f = 1.5$ "fringes." Secant 1 in above nomograph finds turning point A on the pivot scale. Secant 2 gives the value D. Sometimes this value,

(CONTINUED ON PAGE 91)

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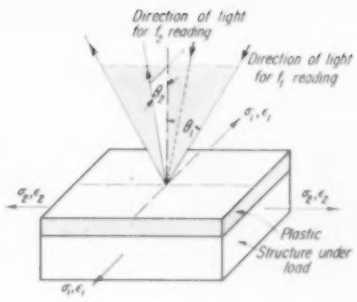
PHOTOSTRESS (CONTINUED)

but not the k factor, will already be known. In this case secant 2 will allow the unknown k factor to be found.

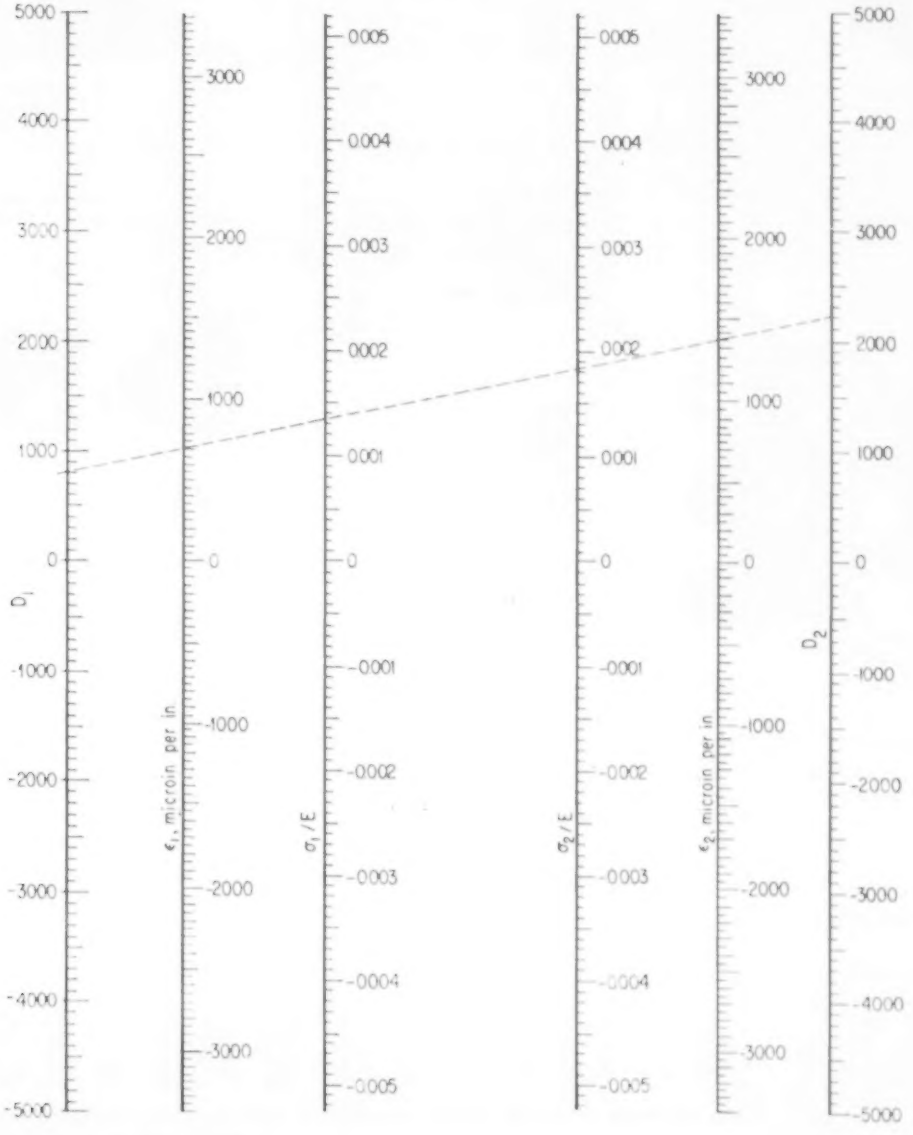
Example 2

Separate values of strains and associated stresses are given by nomograph below. But for these values it is necessary to take two readings for which the light direction must be oblique from the plastic plane (sketch right). The f_1 and f_2 readings will yield σ_1, ϵ_1 and σ_2, ϵ_2 values respectively.



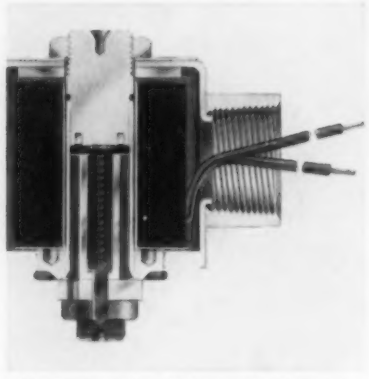
The nomograph is established for $\theta = 45°$ (fixed by instrument construction) $t = 0.120$ in., $k = 0.09$, $f_1 = 0.8$, $f_2 = 2.1$. From nomograph 1, D_1 and $D_2 = 840$ and 2210 microin per in. respectively. A straight line through D_1 and D_2 on nomograph 2 gives ϵ_1, $\epsilon_2 = 710$ and 1355 microin per in. Actual principal stresses σ_1, σ_2 will be $0.00136 \times E$, and $0.00184 \times E$ respectively.

2 — STRESS



Skinner introduces Two-Way Solenoid Valve for Control of High Pressures

New High Pressure Models just added to the Skinner two-way Type R series line of pilot-operated solenoid valves are offered in two-way normally closed construction only. Orifice size is ¼" diameter with ¼" NPT ports. Operating pressure differentials: 5 to 1250 psi on AC voltages and 5 to 1000 psi on DC voltages. Designed for use with such media as air, oil, water and semi-corrosive liquids.



Features. New Skinner Models are built to U. L. requirements in standard and explosion-proof construction. V5-2H type solenoid operator contains stainless steel internal parts to resist corrosion. Valve body is forged naval brass and contains stainless-steel piston assembly, precision machined to close tolerances for positive opening and closing of the main orifice.

Variety of Coil Voltages. Standard coils, built to U. L. standards, are varnish-impregnated and moisture-resistant. Molded waterproof coils are available that will even operate under water and are resistant to fungus growth. Coils are available in wide range of voltages and frequencies.

Standard Pressure Two-way R Series Valves. These two-way valves are available in standard and explosion-proof construction, normally open or normally closed. Pressure operating differentials are 5 to 200 psi for normally closed and 5 to 150 psi for normally open.

Many Desirable Features: Standard pressure R series two-way valves have V5 type operator; stainless steel internal parts; naval brass body; stainless-steel piston assembly; soft synthetic inserts for bubbletight operation. Normally open models have piped-body return. Valve can be mounted in any position.

Custom Installation with these Options. There is a large selection of electrical housings that can be rotated 360° for easy connecting. Also available is manual override that permits opening or closing the valve in the event of current failure.

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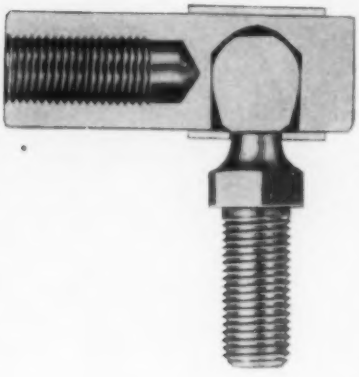
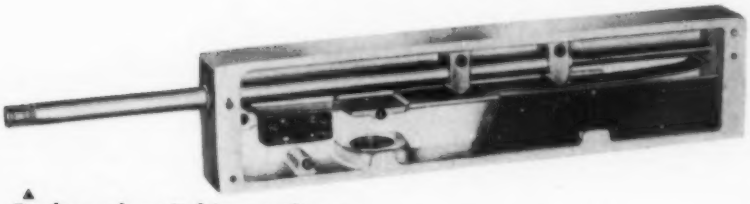


Ball-joint design . . .

is said to increase unit life by factor of 2 or more, compared with conventional designs, while reducing number of parts. Redesigned ball with shorter, heavier neck, increased by 29% in diameter, offers increased wear life of 200% min and increased shear strength. Movement is free at any point in min comical angle of 30° regardless of plane of deflection. Female part of joint consists of joint body and spring-steel retaining sleeve. Cost savings of 30% or more are said to be possible. Functional dimensions of design are interchangeable with SAE and other published standards. Available in ball joints from No. 10-32 through ¾-16. Samples are offered. **Superior Ball Joint Corp, 8935 Trier Rd, Ft Wayne, Ind.**

Circle 300, Reader Service Card



Packaged switching units . . .

control linear machine movements electrically at reported savings of up to 50% over custom-made installations. Electromechanical units are self-contained. The 2-circuit double-break snap-action switches are operated by adjustable cams mounted on rigid, heavy-walled sliding actuator tube that is coupled to air cylinder or sliding machine member. Movement of cylinder operates switches at preset points and controls those machine members that are operated electrically through switches. Standardized actuator bars and cams result in closer alignment to mounted switches and less deflection in internal switch action. Wiring is simplified by use of single conduit. All parts are enclosed in rigid cast-aluminum housing. Terminals are covered by insulating subcover plate. Five standardized units are available for 0-4 in., 0-8 in., 0-12 in., 0-18 in. and 0.24 in. stroke lengths, at list prices of $26.75, $29.50, $32.25, $36, and $39.75, respectively. Immediate delivery. **Linear Controls Co, 3400 Main, Skokie, Ill.**

Circle 301, Reader Service Card

Short-arc welding process . . .

permits manual and mechanized welding of all common metals in 0.030 to 0.100-in. thicknesses in all positions and types of joints. Process utilizes constant potential power supplies incorporating a drooping characteristic. Surge currents can be controlled to limit time duration of arc outages, prevent wire ejection, and produce stable buzzing-type of arc. Arc, operating in range of 30 to 125 amp, 14 to 19 v, short-circuits dozens of times per sec. This produces small, cold puddle that pinpoints arc heat and enables welding of thin materials. There is little or no postweld cleaning. Used primarily with 0.030-in.-dia wire, although 0.020-in.-dia hard wire works well on materials in very low end of thickness range. Approved shielding-gas mixture, manual and mechanized equipment developed to feed small-diameter wires and welding torch from stock. Adaptable, too, to existing inert-gas, consumable-electrode welding equipment. **Linde Co, Div of Union Carbide Corp, 420 Lexington Ave, New York 17.**

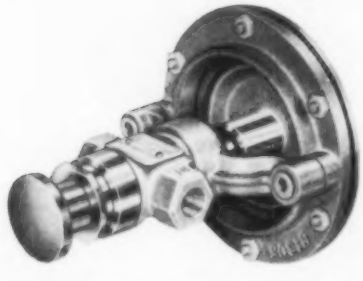
Circle 303, Reader Service Card

Polyethylene molding material . . .

is first of a series to be based on copolymer said to provide outstanding low-temperature toughness, flex life five times longer than existing polyethylene injection-molding materials of similar plastic flow, superior stress-cracking resistance, excellent surface gloss, high rigidity and broad molding latitude. Commercial quantities are now available. Priced at 35¢ per lb. **Union Carbide Plastics Co, Div of Union Carbide Corp, 30 E 42nd St, New York 17.**

Circle 304, Reader Service Card

Auto-manual control valve . . .



automatically interlocks manually controlled circuits or permits manual operation of automatically-operated system. In interlocked circuits, valve can prevent out-of-sequence or accidental manual actuation that might damage machine or workpiece, or injure personnel. In normally automatic circuits, valve permits manual operation for machine setup or in emergencies. For interlocking, a stock diaphragm end section is fitted to standard body with knob, lever or other manual control mounted on opposite end. Manual operation is unrestricted until air is applied to diaphragm end. Fitted with return spring, valve functions automatically, actuated by any 3-way pilot valve, instrument or process control. With actuating pressure off, valve can be operated manually. Available with 2, 3, or 4-way valve bodies. Pipe or open end exhausts are optional on 3 and 4-way valves. Port sizes range from ¼ through 1 in. NPT and flow area through valve is said to equal nominal pipe sizes. Suitable for 20 to 60-psi air actuation or 15-psi instrument pressure, valves will handle intermittent actuation pressures up to 125 psi. Valve bodies are Navy M bronze, with hardchrome plated stainless steel stems. Prices start at $6.25. Delivery, 1 wk or less. **Valvair Corp, 454 Morgan Ave, Akron 11.**

Circle 302, Reader Service Card

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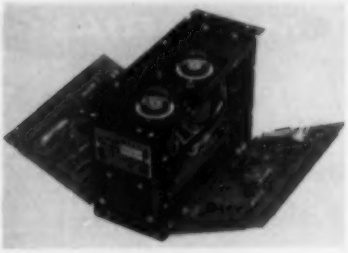


Digital interval timer . . .

is transistor-equipped. Provides accuracy of ±1 count ±0.05% and service life of over 5000 hr. Measures time intervals for a total indicated time of 9.9 (2 decades) or 99.9 (3 decades) millisec. Start and stop signals (contact closures or 10-v pulses) are applied to separate inputs, so that timer indicates which signal started interval. Temperature-compensated 10 KC crystal-controlled oscillator provides reference frequency that is gated to counting unit. Includes pluggable decades and printed circuit cards mounted in hinged sockets. Silicon solid-state devices are used throughout, except in regulated power supply. Portable unit weighs less than 2 lb and occupies 160 cu in. **Erie-Pacific Div, Erie Resistor Corp, 12932 S Weber Way, Hawthorne, Calif.**

Circle 305, Reader Service Card

Stainless honeycomb . . .

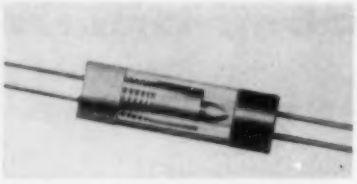
is said to be a lower-cost welded core material suitable for high-temperature requirements. Increased resiliency offers greater resistance to damage during handling and layup operations. Available in $\frac{5}{16}$ and $\frac{1}{4}$-in. cell sizes in 0.001, 0.0015 and 0.002-in. gages. **Hexcell Products Inc, 2332 Fourth St, Berkeley 10, Calif.**

Circle 306, Reader Service Card

Microminiature diode . . .

contained in paper-thin ceramic wafer (0.31 in. sq and 0.016 in. thick) converts ac to dc in electronic circuits. Also acts as switching device. Gold-bonded germanium diode offers peak inverse voltage of 125; dc output of 75 milliamp; forward current of 100 milliamp at 1 v max; max reverse current at room temperature, 10 micromilliamp at 10 v and 50 micromilliamp at 50 v; max reverse current at 167 F, 75 micromilliamp at 10 v and 250 micromilliamp at 50 v. Semiconductors, so small that 650 fit into a cu in. and 350 weigh 1 oz, were developed for Signal Corps' Micro-module program (See *PE—Mar 30, '59, p 19*). Diodes are now commercially available in about 12 different terminations. **Semi-Conductor Div, General Instrument Corp, 65 Gouverneur St, Newark, NJ.**

Circle 307, Reader Service Card



Subminiature thermal relay . . .

with firing sensitivity of 0.2 amp can be used as low-current sensing device or as overload protector. Hermetically sealed by bonding of metal headers to high thermal-shock-resistant glass housing. Transparent glass case permits visual inspection of all working parts. Meets pertinent military specifications. Operates under vibration of 20 to 2000 cps at 15 g with shock rating of 50 g. Temperature range extends from −100 to 400 F. Unit is SPST, normally open, with contact rating of 1 amp. Will handle continuous fuse current of 0.120 amp max and firing current of 0.180 amp min. Fuse resistance is 15 ohm, ±15%. **Networks Electronic Corp, 14806 Oxnard St, Van Nuys, Calif.**

Circle 308, Reader Service Card

Magnetic device . . .

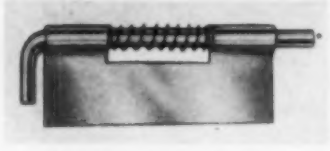
for hydraulic reservoirs removes ferrous particles in accordance with new JIC standards. Furnished with support rods of any length needed to fit particular reservoir. Will fit through opening of 2-in. pipe flange and can be attached to standard pipe plug. Can also be fastened to cover of any opening larger than 2¼ in. dia. Available in 8 standard sizes, ranging from single unit for 10-gal. reservoirs to multiple units for 350 gal. reservoirs. Each unit consists of 3 Alnico V magnets and two pole pieces that increase magnetic effective area to about 15 sq in. **Kebby Co, 2320 Custer Ave, Rockford, Ill.**

Circle 309, Reader Service Card

Solid-state relay . . .

protects electrical equipment, silicon diodes, coaxial cables and similar units from surges and peak transients generated from lighting or local causes. Though it may be connected across an 800-v source continuously, leakage is reported to be 4.1 microamp and at 250 v it draws nothing. Should surge appear, resistance drops to dead short that is shunted into resistor. Miniature unit is available in all voltages up to 1200 v. Dimensions are $\frac{3}{8}$ in. dia x $\frac{3}{4}$ in. long, excluding flexible lead. May be used as an inverter in suitable circuit, if cooled in proportion to load involved, or to open a circuit up to 33,000 v by reduction in voltage below a critical value. Sample units are available at $16 each. **Clark Electronic Laboratories, Research Products Div, Box 165, Palm Springs, Calif.**

Circle 310, Reader Service Card



Instant-release latch hinge . . .

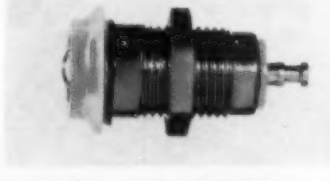
is composed of housing and pin, with captured spring. Adaptable to electronic cabinets, ground equipment, release boards and panels, inspection units and service doors. Any hinged part can be taken off or put back at a touch. Strong bearing surfaces provide easy release and action under load. Spring locks part to position when in use. Immediately available in several standard assemblies. **Burklyn Co, 3429 Glendale Blvd, Los Angeles 39.**

Circle 311, Reader Service Card

Flexible lightweight tubing . . .

for pneumatic and hydraulic use is made from natural-color polyamide formulation. Offered in two basic types for low-pressure applications to 1500 psi and for medium-pressure service to 2500 psi. Both are available with $\frac{1}{8}$, $\frac{5}{32}$, $\frac{1}{4}$, $\frac{5}{16}$ and $\frac{3}{8}$ in. OD. Wall thickness varies with intended service, OD and other factors. Operates at temperatures to 150 F max. Now in quantity production for short-term delivery. Shipped in standard 500-ft coils in heat-sealed polyethylene bags. Said to be lower in cost than conventional tubing. **Synflex Products Div, Samuel Moore & Co, Mantua, Ohio.**

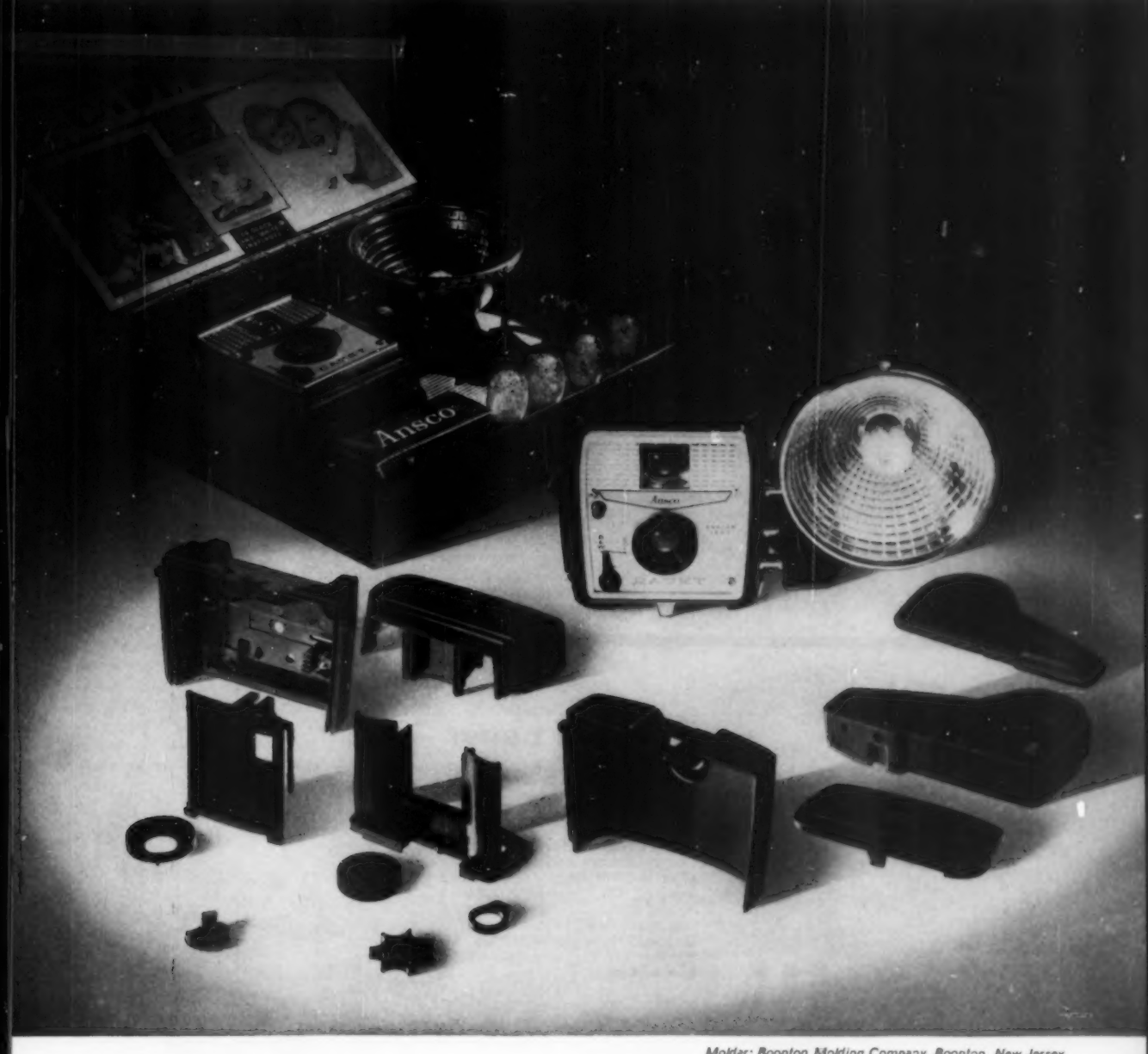
Circle 312, Reader Service Card



Low-voltage panel lights . . .

for low-current applications are suited for a wide range of visibility with Type 344, 10-v, 15 milliamp bulbs, including flip-flop and transistor-equipped circuits. Base holds bulb so that end projects in

. . . CONTINUED ON PAGE 96



Molder: Boonton Molding Company, Boonton, New Jersey.

ANSCO CADET

gets precision fit from 13 molded DYLENE® plastic parts

A low-cost camera built to last! By using DYLENE polystyrene, Ansco produces smart, yet economical plastic cameras. Each camera is assembled quickly and efficiently, because these DYLENE plastic parts are consistent in size and shape. In short: each part fits letter-perfect every time.

DYLENE is a designer's plastic. You can choose from over 15 formulations, a DYLENE polystyrene which offers you the best balance of these outstanding properties: fast moldability, high heat and shock resistance, a smooth, glossy finish, a wide range of color possibilities—and photographically opaque.

Koppers has a competent, well-trained plastics engineering staff. These men are available for discussions about your future production plans. If you are considering a new product or redesigning an old one, they will help you choose the DYLENE formulation best suited for your operation. Call your Koppers representative, he will give you the information you need.

Remember, whatever your design problem, be sure to consider DYLENE polystyrene. For more information, write to Koppers Company, Inc., Plastics Division, Dept. PE-69, Pittsburgh 19, Pennsylvania.

See our catalog in SWEET'S

Offices in Principal Cities · In Canada: Dominion Anilines and Chemicals Ltd., Toronto, Ontario

KOPPERS PLASTICS

DYLENE® expandable polystyrene, SUPER DYLAN® polyethylene and DYLAN® polyethylene are other fine plastics produced by Koppers Company, Inc.

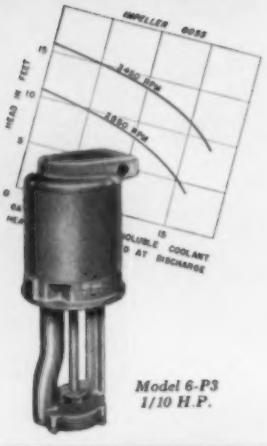
KOPPERS

CIRCLE NO. 95 READER SERVICE CARD

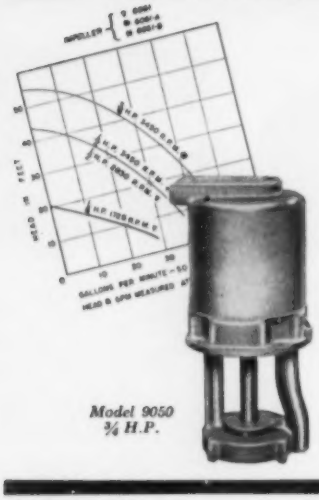
Machine tool builders know...

No matter what size . . .

Yes, there is a Ruthman Gusher Coolant Pump that will exactly fit your coolant pump requirements from the P-3 Series (Baby Gusher) with 1/10 H.P. to the largest 7½ H.P. Series. Gusher Pumps are available in Immersed, Pipe Connected, Flange Mounted and Tank Units.



Model 6-P3 1/10 H.P.



Model 9050 ¾ H.P.

You get better results . . .

You can be sure that Gusher Coolant Pumps will give you year after year of highly satisfactory service. Their simple, compact design reduces maintenance to a minimum and the electronically balanced rotating assembly increases bearing life, cuts vibration and wear.

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COOLANT PUMP

Follow the leading machine tool builders and specify Ruthman Gusher Coolant Pumps on your metal cutting machinery.

Model 6-P3 Pump in Tank No. 1-4800 equipped with Casters for complete portability

Write for our complete catalog today.

THE Ruthman MACHINERY CO.

1818 Reading Road, Cincinnati, Ohio

- COOLANT PUMPS
- CIRCULATORS • AGITATORS
- MOLTEN METAL PUMPS

front of panel. No lens or other part is in front of bulb to reduce illumination. Nylon rim, available in five standard colors, provides color identification and insulation of receptacle. May be mounted in any plane. Both flange and screw body models are offered. **Sloan Co, 4029 Burbank Blvd, Burbank, Calif.**

Circle 313, Reader Service Card

Dihedral coupling . . .

will give up to 5° misalignment per set of gear teeth in applications where shaft misalignment is too great to be handled by standard gear couplings. The close fit on machined surfaces of rigid hubs permits gear teeth to be used for driving only. All parts are alloy steel. Couplings are provided with floating shafts to customer specifications. Machined from forged steel and have nylon plug inserts in each end. Plugs limit axial float and prevent wear to lathe centers of roll shafts. Available in shaft sizes from 1¼ to 4½ in., with ratings of 3½ to 210 hp per 100 rpm, respectively. **John Waldron Corp, Sub of Midland-Ross Corp, PO Box 791, New Brunswick, NJ.**

Circle 314, Reader Service Card

Miniature lubricating unit . . .

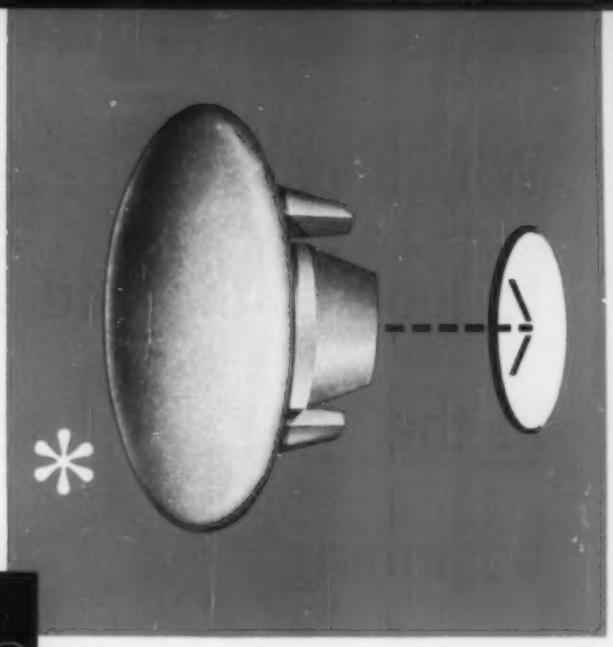
pre-measures and injects fluid lubricants to millionths of an oz in automatic cycles as often as every minute in machinery application. Automatically controlled, air-operated pump supplies lubricant to small injectors with micrometer adjustment at predetermined rate in quantities of 200 millionths of an oz minimum. System is

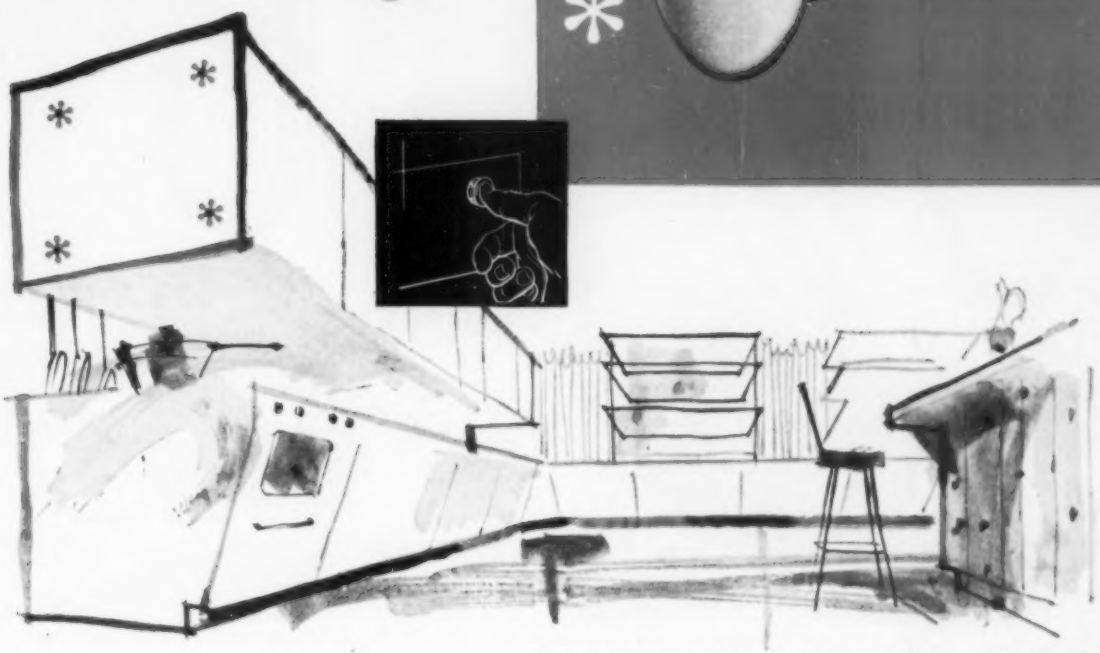
(Continued on page 100)

Good looks count

. . . and you can count on improved product appearance with

Plasti-Plugs®





Plug production holes

Ventilation plugs

Cover access holes

Silent drawer glides

Metal kitchen cabinets with unsightly production holes showing? Not if Fastex Plasti-Plugs (one piece, self-retaining hole plugs) are used! Snapping-in with a light touch of the finger, Plasti-Plugs are available in 45 standard sizes, in colors to match every product. Low in cost to buy and apply, Plasti-Plugs do double duty too—can be used for dust protection, friction glides and as replaceable plugs. Special moisture-sealing plugs may also be had. Made of polystyrene, nylon or vinyl, they're non-corrosive, always good-looking.

Write for free catalog. 45 standard sizes listed . . . tells how easily you can "snap in" Plasti-Plugs by Fastex.

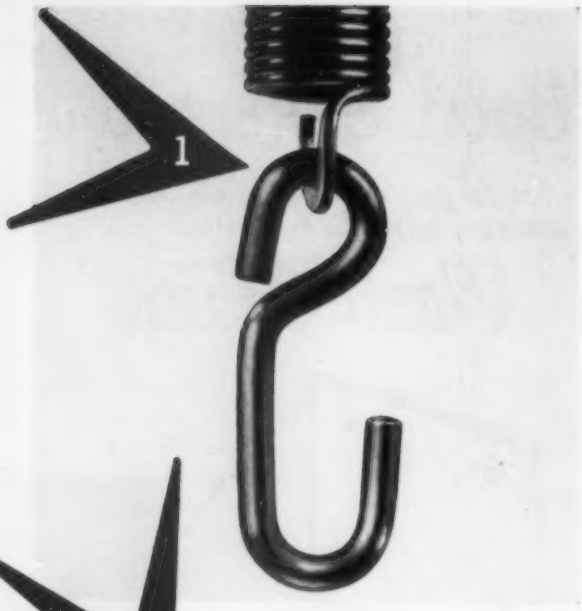
Trade Mark

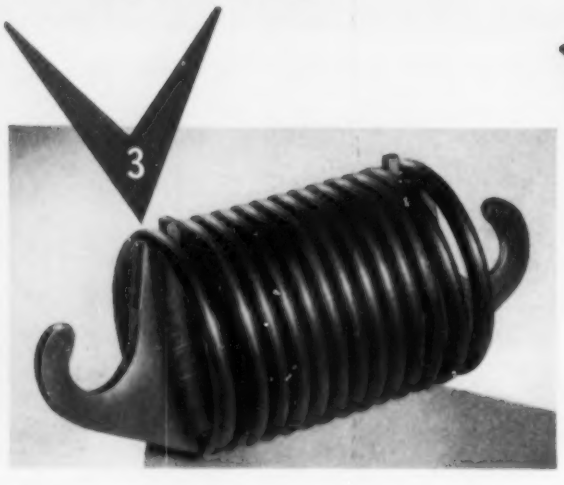
FASTEX

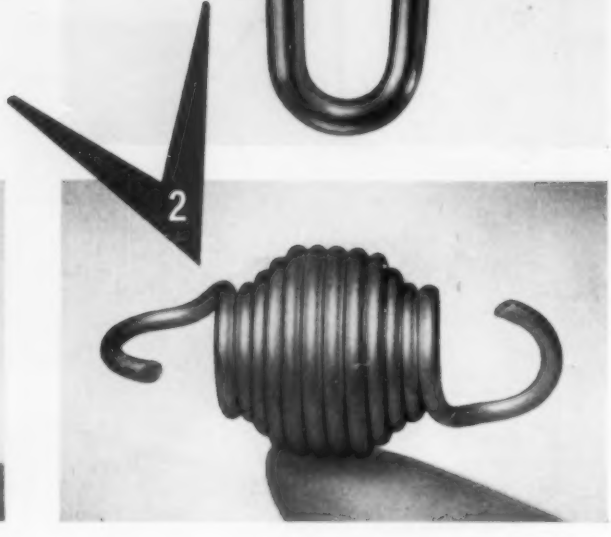
195 Algonquin Road, Des Plaines, Illinois
In Canada: Canada Illinois Tools Limited, Toronto, Ontario

FASTEX
SHAKEPROOF
DIVISIONS OF ILLINOIS TOOL WORKS

Why it pays to look at the end in the beginning







1. In this pick-arm spring for a textile machine, natural frequency vibration plus rigid end restraint caused early failure. By redesigning spring and adding swivel hook to end assembly, failure was avoided and cost reduced as well.

2. Fatigue failure caused by bending stresses occurs where end hooks join working coils. In this method of reducing the combined stress, two coils at each end are wound with a reduced diameter.

3. Another method for reducing stress concentration where end hooks join coils is to thread a flat stamping into end coils.

Here are a few examples of why it pays to call on the springmaker early in your design problems. End-hook failure of extension springs is a common occurrence that experience can help avoid. Check your specifications for performance and production economy by consulting an A.S.C. spring engineer. Write for bulletin "How to Solve Your Spring Design Problems."

5903

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
Raymond Manufacturing Division, Corry, Penna.
Ohio Division, Dayton, Ohio
F. N. Manross and Sons Division, Bristol, Conn.
San Francisco Sales Office, Saratoga, Calif.
Seaboard Pacific Division, Gardena, Calif.
Cleveland Sales Office, Cleveland, Ohio
Dunbar Brothers Division, Bristol, Conn.
Wallace Barnes Steel Division, Bristol, Conn.

Canadian Subsidiary: Wallace Barnes Co., Ltd., Hamilton, Ont. and Montreal, Que. Puerto Rican Subsidiary: Associated Spring of Puerto Rico, Inc., Carolina, P.R.

FALK All-Motor Motoreducers driving pipe conveyors in seamless tube mill.

Photo courtesy of
The Colorado Fuel and Iron Corporation

You get these "extras" when you buy FALK *all-steel* Motoreducers

1. **Freedom from damaged housings.** The exclusive FALK *all-steel* construction gives full protection from cracked housings or torn-off feet...plus twice the ability of cast iron to maintain vital alignment.

2. **12-15% reserve load-carrying capacity** in the gears, by AGMA standards. The extra-depth, high pressure angle helical gears are another FALK exclusive ...they assure better operation and longer gear life.

3. **Highest known gear efficiency**—98½% per gear train under full load! This means maximum productive work for your power dollar.

4. **Longer service life**...advanced FALK design makes it possible to machine both bores for each shaft assembly at one time, thus eliminating possible accumulation of tolerances that occurs when individually machined parts are assembled. The result—better alignment of revolving elements that permits units to transmit rated capacity longer.

5. **Standard units to fit your needs.** Integral and All-Motor® Motoreducers are available in horizontal, vertical and right angle types...a type for every use.

Units are available up to 75 hp; output speeds from 780 rpm down to 1.2 rpm. Prompt delivery from factory, warehouse or distributor stocks. Ask your FALK Representative or Authorized FALK Distributor for *Bulletin 3100*.

THE FALK CORPORATION, MILWAUKEE 1, WIS.

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in most principal cities

FALK

...a good name in industry

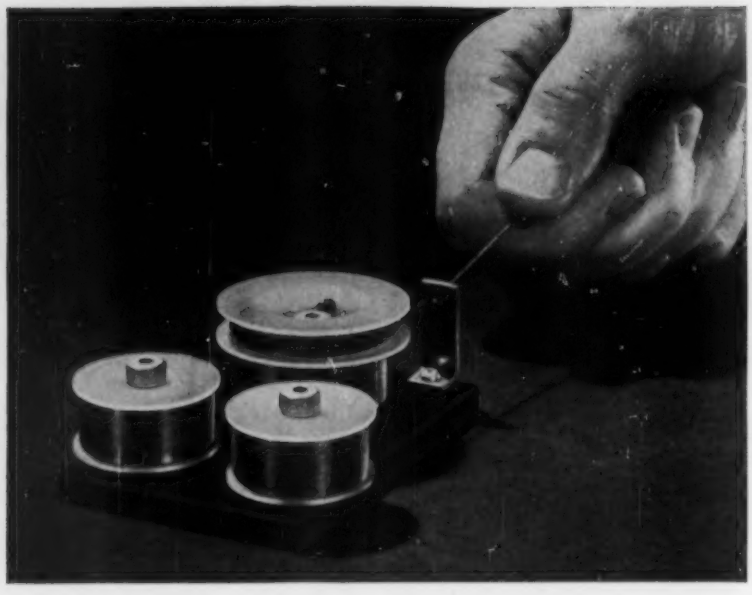
THE FALK ALL-MOTOR® MOTOREDUCER
the original All-Motor unit

(Shown) Horizontal concentric model. Also available in right angle and vertical types.

THE ALL-STEEL FALK® SHAFT MOUNTED DRIVE

Proved best for the countless industrial applications where a reducing unit mounting directly on shaft of the driven machine is indicated.

Units from 1/2 to 50 hp. Ratios —4:1, 14:1 or 24:1. Torque capacity up to 41,000 lb-in (in standard units). Prompt shipment from stock. For details, ask for *Bulletin 7100*.



NEG'ATOR® MOTORS FROM STOCK

for Experimental Designers

As a time-and-cost saving shortcut for design engineers who need a means for applying constant tension forces through long deflections, Hunter now offers six stocked models of constant-torque NEG'ATOR Spring Motors.

Originally developed for use as "idea tools" for experimental design, standard NEG'ATOR Motors have found wide application as product components. For this reason, models carried in stock have been expanded to provide cable-tension ranges from 0.375 lb. through 5.0 lbs., as indicated by the table below.

Orders for stock motors will be shipped immediately. Prices are shown in the table.*

Model No.	Spring Torque in Lb.-in.	Cable Tension in Lbs.	No. Revolutions	Cable Length in In.	Endurance (Min. No. Cycles)	Price
P7172	.1	0.375	20	36	3,000	$5.00
A2025-1	.78	1.0	15	72	7,500	8.00
A2025-2	1.56	2.0	15	72	2,500	8.00
A2025-3	2.33	3.0	15	72	4,500	12.00
A2025-4	3.12	4.0	15	72	2,500	12.00
A2025-5	3.90	5.0	15	72	2,000	12.00

P7172 MATERIALS: NEG'ATOR Springs—stainless steel; Drums—Nylon; Bases—aluminum; Cable—Nylon.

MATERIALS, OTHER MODELS: NEG'ATOR Springs—stainless steel; Drums—Nylon; Bases—Black Plastic; Cable—stainless steel, preformed.

**Prices shown are not indicative of the cost of NEG'ATOR Springs when made in quantity, to specifications, for large-volume motor and other applications.*

For a good idea on how NEG'ATOR Springs are being applied, ask for Issue 12 of the NEG'ATOR SKETCHBOOK.

HUNTER SPRING COMPANY

A Division of American Machine and Metals, Inc.

5 Spring Avenue, Lansdale, Pennsylvania

SPRINGS · STAMPINGS · QUALITY CONTROL EQUIPMENT

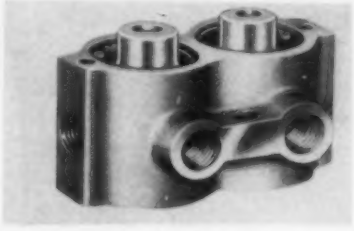
said to maintain constant, uniform oil film on all bearing surfaces with no overflow and no dripping. **Lincoln Engineering Co, Industrial Div, 4010 Goodfellow Blvd, St Louis 20.**

Circle 315, Reader Service Card

Impulse footswitch . . .

about the size of a cigaret pack pulses only when depressed. Does not actuate on return stroke. Steel housing has sponge rubber base pad. SPDT model is rated 20 amp, 125/250 v ac. DPDT model will be available, rated at 10 amp, 125 v ac. For such applications as actuation of solenoids and other snap-action, momentary actuations. **Linemaster Switch Corp, Woodstock, Conn.**

Circle 316, Reader Service Card



Pilot-operated valves . . .

for air, gas, vacuum and liquid flow. Suitable for pressures to 125 psi, Buna-N diaphragms cycle from full-open to dead-seal shutoff at up to 30,000 per hr. Opening, closing and exhausting are powered by line pressure, requiring trigger impulse from pilot. Pilot medium (gas or liquid) is separate from medium being valved. Design eliminates springs, packings, pistons and metal-to-metal wearing contacts. Ports are full-rated capacity throughout in 2 and 3-way sizes of ⅛, ¼, and ½ in. and 4-way 5-port ¼-in. model for double-acting cylinder control. Pilot line connectors are all ¼ in. NPT. Bodies are machined solid steel, cadmium-plated high tensile iron or cast brass, normally open or closed. Valves operate in temperatures of −65 to 225 F. **Humphrey Products, Div of General Gas Light Co, 202-X2 N Park St, Kalamazoo, Mich.**

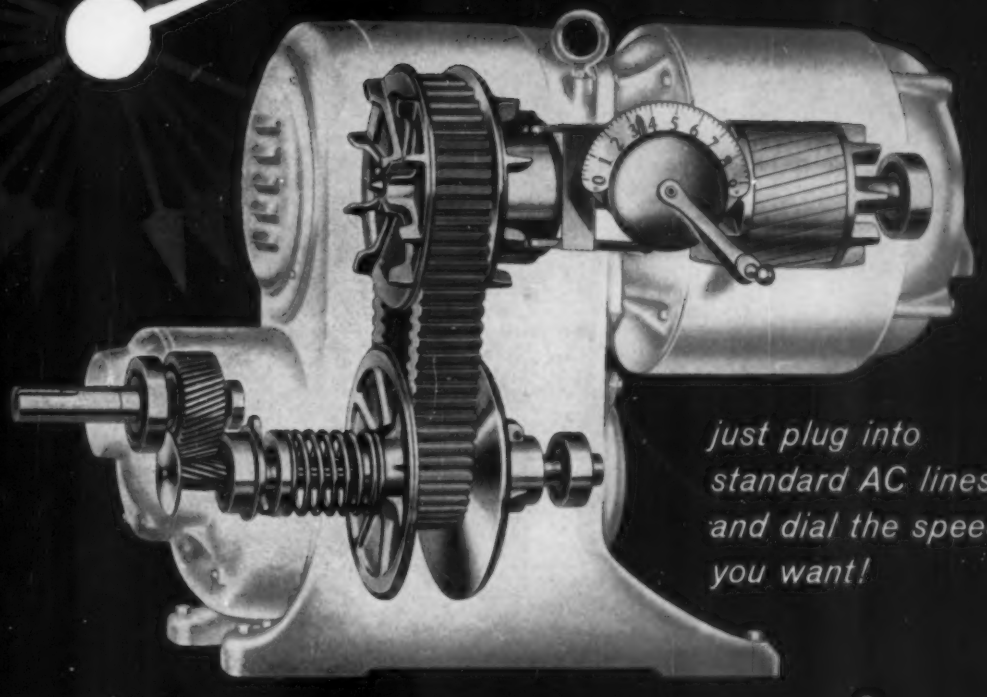
Circle 317, Reader Service Card

Shaft-mounted reducers . . .

with single-reduction gearing have capacities of 1 to 40 hp. Output speeds range from 90 to 420 rpm. Double-reduction units are rated 1 to 30 hp, with output speeds 10 to 160 rpm, and use standard V-belts and pulleys. Equipped with torque arm for infinite belt adjustments. Unit may be operated over wide speed range by using variable pitch pulley or by changing

(Continued on page 104)

any RPM simply on AC!

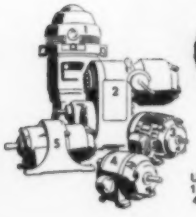


just plug into standard AC lines and dial the speed you want!

U. S. VARIDRIVE Motors

...one unit...infinite speeds!

So *simple* to get any speed you want, directly from standard AC power lines—with U.S. VARIDRIVE MOTORS! One compact, self-contained unit does it. With U.S. VARIDRIVE, you don't have to buy a DC converter, DC generators, complicated and delicate electronic circuits. Just *plug in* this one simple unit—dependable, easy for your regular personnel to maintain. You merely dial, and get smooth, stepless speed changes immediately! Thus, you set speeds for maximum production as needs vary...*increase* machine efficiency...output...product quality! *Decrease* costs...rejects...manpower and materials waste! Available in RATINGS: ¼ to 75 H.P. Specify: "U.S. VARIDRIVE MOTOR."



U.S. MAJOR MOTOR LINES INCLUDE:
1. Vertical Solid & Holloshaft, 2. Varidrive, 3. Totally Enclosed, 4. Uniclosed, 5. Syncrogear. Also, many other special motors.

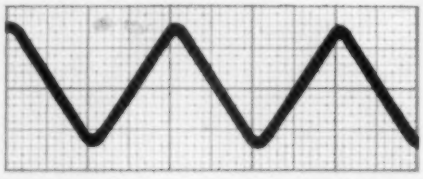
U.S. ELECTRICAL MOTORS INC.

BOX 2058, LOS ANGELES 54, CALIFORNIA
OR MILFORD, CONNECTICUT

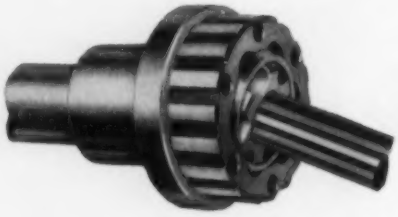
FREE COLOR BROCHURE
...Send for U.S. Varidrive Bulletin No. 1797

3-minute "post-grad course"
IN TORQUE TRANSMISSION

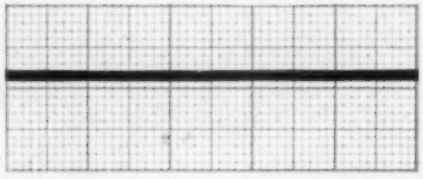
ORDINARY CARDAN UNIVERSAL JOINT



Mathematics and geometry prove this design joint continually changes shaft output velocity. During each revolution there are two high points, and two low points of speed and torque variation. This fluctuating torque action causes vibration and wear throughout entire driving mechanism.



CONSTANT VELOCITY JOINT



This RZEPPA design joint *continually* transmits 100% smooth torque at all joint working angles. Such smooth torque action results from the drive balls applying force in a plane that bisects both input and output shaft axes.

Do you have a torque transmission problem that requires any one or a combination of these design improvements:

Less vibration	*Higher speeds*
Reduced bearing wear	*Greater angles*
Longer shaft life	*More capacity*

And, if your application warrants placing the solution and ultimate cost-savings above ordinary, lower priced joint designs . . . RZEPPA can help you.

RZEPPA Constant Velocity Joints are available for *light*, *medium* and *heavy* duty applications on air and space craft, vehicles and industrial machinery.

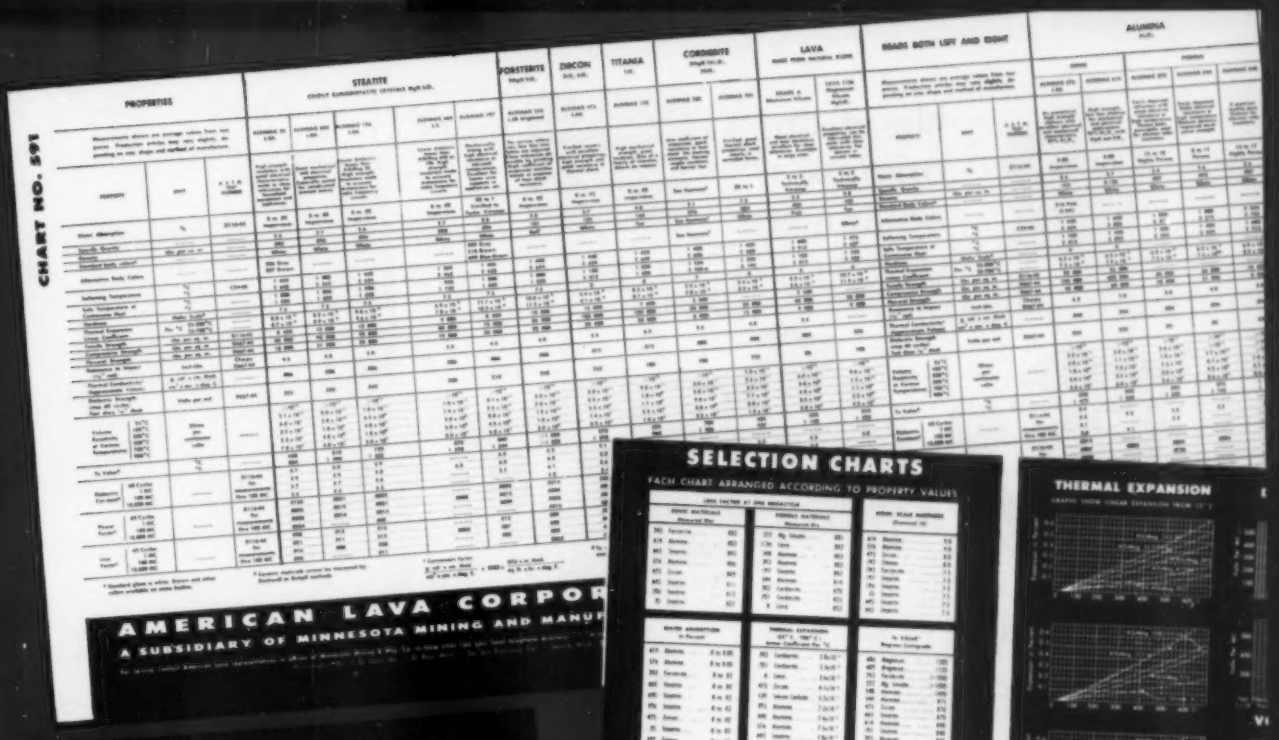
WRITE FOR LATEST LITERATURE or send your dimensional sketch along with peak horsepower, R.P.M. and operating angles. Without obligation, our engineers will assist you. Address: THE GEAR GRINDING MACHINE CO., Dept. PJ-659, 3901 Christopher Street, Detroit 11, Michigan.

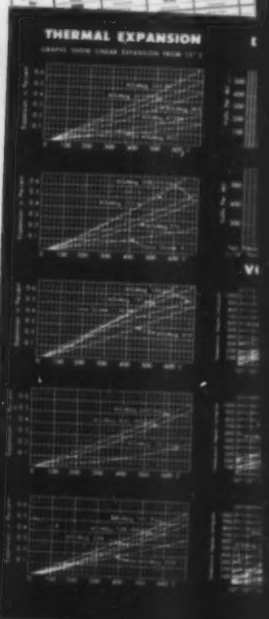
(PRONOUNCED: "SHEPPA")

RZEPPA

CONSTANT VELOCITY UNIVERSAL JOINTS

Genuine RZEPPA Joints are made exclusively by THE GEAR GRINDING MACHINE CO.





NEW PROPERTY CHART OF ALSIMAG® TECHNICAL CERAMICS

Yours on Request!

WHAT ALSIMAG IS

The AlSiMag trade mark includes the widest variety of technical ceramics available from any single source . . . backed by the most inclusive custom manufacturing facilities in the industry. Now well into its second half century of leadership in technical ceramics, this is the place you are most apt to get what you want, when you want it.

WHAT THE CHART TELLS

The chart gives principal physical and electrical characteristics of the most frequently used AlSiMag compositions. If your work includes design, production or purchasing you will find this chart valuable. It is completely factual and is of convenient file size.

WHERE ALSIMAG IS USED

AlSiMag ceramics are unexcelled in electronic and electrical applications because of their superior dielectric properties, especially at elevated temperatures. They have many mechanical and chemical applications.

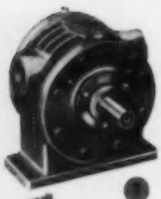
You may choose compositions from this chart which have various combinations of these characteristics. Permanently rigid. Chemically inert. Withstand high temperatures. Hard (up to 9 on Mohs' scale) and abrasion resistant. Non-magnetic. Will not rust, oxidize or corrode. Do not deteriorate with time. Metal-ceramic combinations can be accomplished. Materials are available with expansion coefficients varying over a wide range. Precision tolerances can be maintained. The chart, sent on request, gives details, saves you valuable time.

A Subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
58TH YEAR OF CERAMIC LEADERSHIP

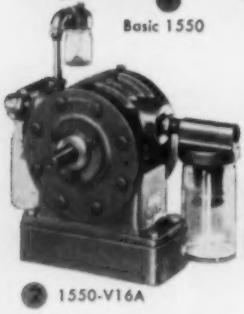
For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston: Newton Center, Mass. • Chicago: Bedford Park, Ill. • Cleveland, O. • Dallas, Texas • Los Angeles, Cal. New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash.
All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.



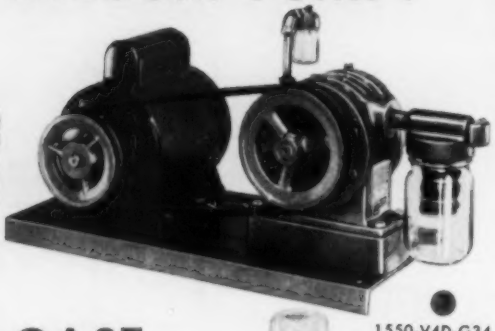
Basic 1550

Need an original equipment VACUUM PUMP?

ROTARY AIR GAST PRODUCTS

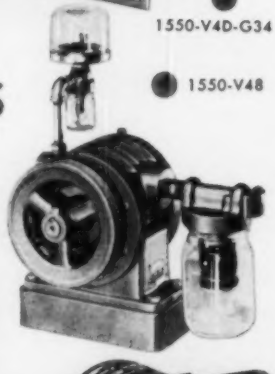


1550-V16A



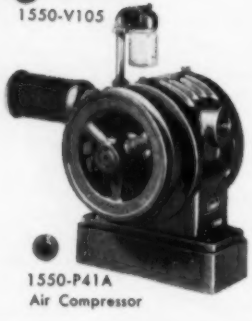
1550-V4D-G34

SEE HOW GAST CUTS YOUR COSTS



1550-V48

1550-V105



1550-P41A
Air Compressor

These pictures demonstrate how *your* product —and cost budget—may benefit when you select Gast rotary Vacuum Pumps for original equipment.

Above (1) is a basic Model 1550 less accessories (one of 13 sizes). For current, active customers, Gast builds this model in dozens of variations. Each one meets specific needs for vacuum, pressure, lubrication, drive method and type of service.

For example, (2) is equipped with wick oiler, and intake and outlet filters for both vacuum and pressure used on paper feeding applications. (3) includes fan-pulley, belt, motor and base as sold for intermittent operation on vacuum-back cameras, vacuum chucks and plastic sheet forming units. (4) has new, large constant-level oiler for rigorous industrial duty. (5) *never* needs oil—has carbon vanes for oil-free air. (6) is a 1550 Model Air Compressor with air intake filter.

As you see, each original equipment buyer gets a job engineered pump. *In the same way, you can save money, because Gast ingenuity—and tooling and manufacturing efficiency—permit precision quality at production prices.*

WRITE FOR FULL DETAILS—REQUEST CATALOG

GAST MANUFACTURING CORP., P.O. Box 117-V Benton Harbor, Michigan

SEE CATALOG IN SWEET'S PRODUCT DESIGN FILE OR FLUID POWER DIRECTORY

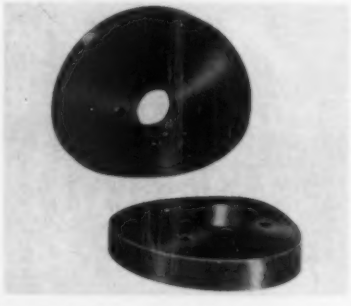
GAST ROTARY

- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

"Air may be your answer!"

sheave combinations. Optional built-in backstop prevents reverse rotation. Reducers are equipped with high hardness design gearing. **Lima Electric Motor Co Inc, Dept 145, Lima, Ohio.**

Circle 318, Reader Service Card



Standard cam designs . . .

for plate and face cams are said to reduce production costs. Standard cam blanks and preselected strokes, timings and followers are used. Plate cams have strokes from ¾ to 3 in. and are for use with needle bearing followers of varying diameters. Timings are of 60, 90 or 120° with two dwells. Acceleration characteristic may be modified trapezoid or modified sine. No tooling charge is made for masters from which cams are traced. Blanks are high-strength alloy steel prehardened to Rc-30 and machined with light finish cuts. To simplify selection, graphs are provided to show relationship between stroke, movement and size of blank. Company also prepares calculating tables and drawings for special cams. **Ferguson Machine Corp of Indiana, 7818 Maplewood Industrial Ct, St Louis 17.**

Circle 319, Reader Service Card

Close-coupled pump-motor . . .

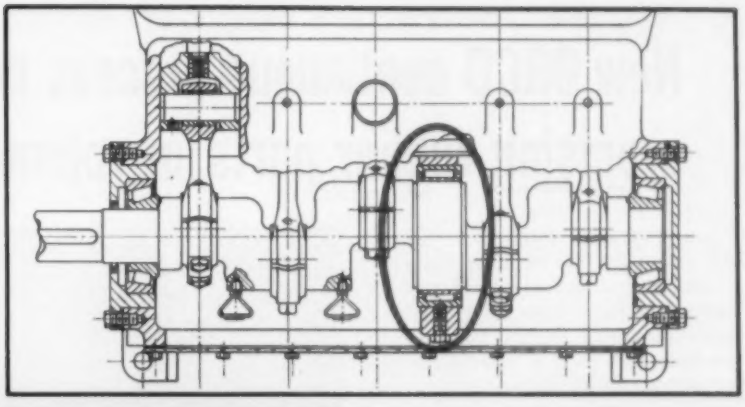
combination measures 5 x 9⅛ in. and incorporates totally enclosed motor with rating of 1/12 to ½ hp and internal gear pump

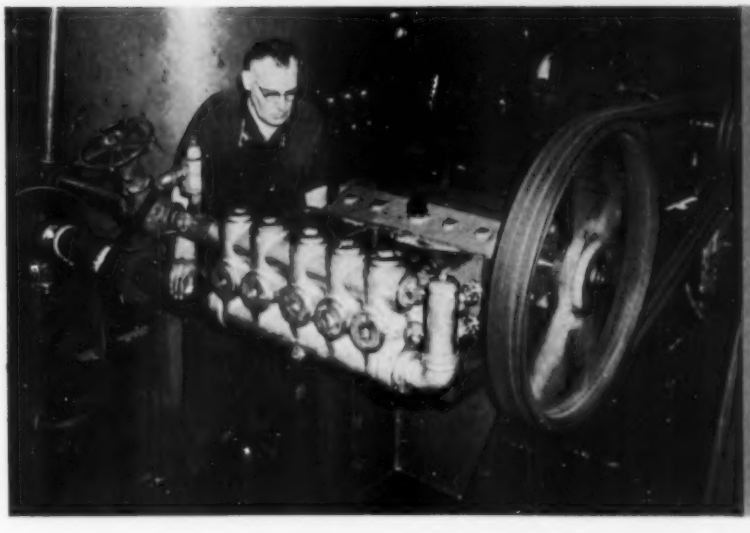
(Continued on page 108)

All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

ORANGE *Cage Type* NEEDLE BEARINGS

selected for Center Main Bearing in Crankshafts of WORTHINGTON HORIZONTAL QUINTUPLEX PLUNGER PUMPS





ADVANTAGES GAINED

- Non-skewing roller action
- Ease of assembly
- No adjustment necessary

Cutaway of crankshaft section of Worthington Horizontal Quintuplex 5-Plunger Pump, shows installation of 8" O.D. Orange Cage Type Needle Bearing, with special I.D. inner race. It produces an efficiently designed bearing to maintain rigidity of the crankshaft.

With the Orange cage design, precision needle rollers are positively and permanently aligned along the entire length of the roller periphery. The rollers resist skewing, even under conditions of overhung mountings—shaft deflection—misaligned housings—vertical mountings—uneven loading.

As a result, Orange Cage Type Needle Bearings are extremely quiet and even-running, with low internal friction. You can design to gain the high load-small space advantages of needle bearings in a broader range of application.

Orange Cage Type Needle Bearings are available in all standard sizes from ½" to 9¼" shaft diameters. Sealed types in 24 sizes from ½" to 2"; also separate cage-and-roller assemblies (without races) to meet extreme space restrictions.

Write for new 48-page Engineering Reference Manual giving specifications on all Orange Cage Type and other Orange Roller Bearings.

ORANGE
ROLLER BEARINGS

ORANGE ROLLER BEARING CO., Inc.
551 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings
Journal Roller Bearings — Thrust Roller Bearings
Cam Followers

CIRCLE NO. 105 READER SERVICE CARD 105

ORCO

"Customeered" components basic to industry

ideas on "Customeered" RUBBER PARTS

...their design and application for improved product performance **No. 1**

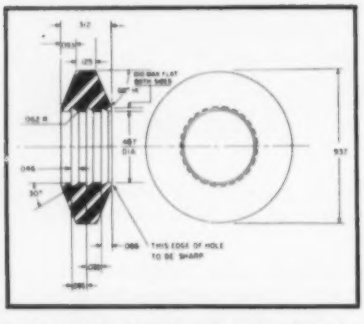
New ORCO continuous process now custom molds precision rubber parts in volume—at less cost!

Precise tolerances within ±0.003 in. are now possible in large volume production of custom-molded rubber component parts. Ohio Rubber's new high-speed, continuous molding process produces such parts at rates of up to 200,000 pieces per day.

Greater precision, which results in important savings on finishing costs, is assured through use of single-cavity, self-registering molds. They permit accurate, uniform application of pressure to minimize flash—maintain consistent tolerances for all dimensions. Uniform material thickness is equally assured by a plasticizing mill, which as an integrated part of the process directs uniform charges to each mold.

Direct feeding, from the mill to the mold wheel, eliminates the conventional intermediate extrusion step and further insures part uniformity and quality consistent with specifications. The continuous process permits *precise* control of time and temperature for each part.

Wide range of parts being more economically produced through Ohio Rubber's new molding process include (top, left to right): valve stem deflector, condenser seal, (bottom) seal piston rod packing, universal joint seal, and oil seal. These, like all the many other small, *precision* parts already produced or being produced, vary in dimensions up to 1½" in diameter and 1" in thickness.



High-precision is indicated in the close tolerances of this quadruple-landed seal for auto shock absorbers—more economically produced in volume through Ohio Rubber's new high-speed, continuous molding process.

Large volume production results in substantial cost savings for small, precision parts requiring tolerances obtainable by other precision molding processes. For parts formed by less precise, conventional methods, performance can be improved through greater accuracy—and without prohibitive increase in cost.

Quantity requirements involving 500,000 or more parts annually are recommended for most advantageous use of the new process. Since two similar parts of different size can be produced simultaneously by alternating the molds on the molding wheel, lower production runs which might not be economical can be combined with a separate order.

Complete information on this revolutionary new process is available in bulletin form. Send for your free copy today. At the same time, be sure to inquire about Ohio Rubber's complete component "Customeering" service—molding, extruding, and bonding-to-metal. Just mention ORCO Bulletin 715.

9DE1

ORCO

THE OHIO RUBBER COMPANY

WILLOUGHBY, OHIO

A DIVISION OF THE EAGLE-PICHER COMPANY

EAGLE EP PICHER

106 CIRCLE NO. 106 READER SERVICE CARD

CIRCLE NO. 107 READER SERVICE CARD →

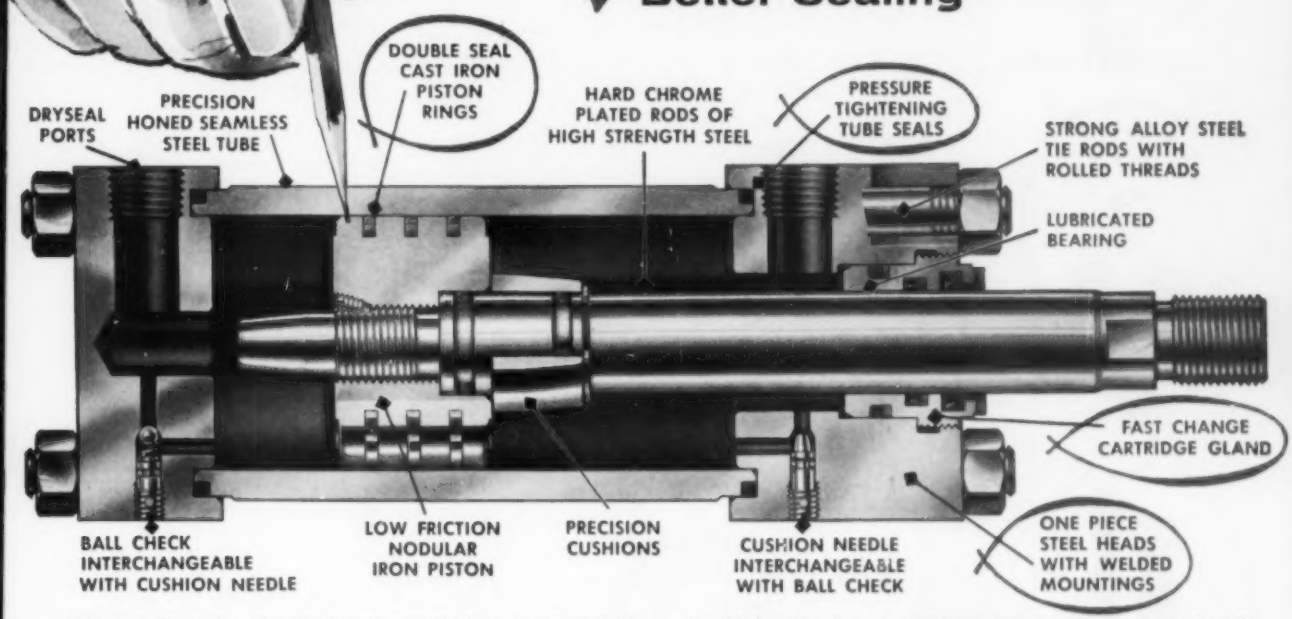
Your specifications

...a part of

Powrdraulic CYLINDERS

✓ Greater Factor of Safety

✓ Better Sealing


DRYSEAL PORTS
PRECISION HONED SEAMLESS STEEL TUBE
DOUBLE SEAL CAST IRON PISTON RINGS
HARD CHROME PLATED RODS OF HIGH STRENGTH STEEL
PRESSURE TIGHTENING TUBE SEALS
STRONG ALLOY STEEL TIE RODS WITH ROLLED THREADS
LUBRICATED BEARING
FAST CHANGE CARTRIDGE GLAND
ONE PIECE STEEL HEADS WITH WELDED MOUNTINGS
BALL CHECK INTERCHANGEABLE WITH CUSHION NEEDLE
LOW FRICTION NODULAR IRON PISTON
PRECISION CUSHIONS
CUSHION NEEDLE INTERCHANGEABLE WITH BALL CHECK

HANNA Powrdraulic Hydraulic Cylinders meet J. I. C. recommendations and have industry standard mounting dimensions—2000 psi and 3000 psi non-shock. 1½" through 8" bores.

EXCLUSIVE PRESSURE TIGHTENING TUBE SEALS, located on the outside diameter of the cylinder tube, form a positive seal at all pressures from zero to maximum. Minute expansion of the tube due to pressure, squeezes the "O" ring making the seal even tighter. The "O" ring is fully confined between the head and the tube and will not extrude at high pressures. Unlike other cylinders that seal at the tube ends or inside diameter, the Hanna Powrdraulic Cylinder with pressure tightening O.D. seals will remain tight at all pressures.

DOUBLE SEAL PISTON RINGS give you twice the sealing power of conventional piston rings. These bi-directional, cast iron rings, consisting of a ring within a ring, seal both the "in" stroke and the "out" stroke of the cylinder. The piston with double seal rings is packed for life and never should need replacement. You may also choose the optional piston with "U" type synthetic packings.

FAST CHANGE CARTRIDGE GLAND equipped with a leak proof, low friction rod seal forms a tight seal from zero to maximum pressure. Built in rod wiper removes dirt and particles from piston rod as the rod moves "in" and serves as another hydraulic seal to wipe the rod dry on the "out" stroke. You can select either the standard gland or the optional, multiple lip, spring loaded seal. The optional gland is interchangeable and is available with synthetic rubber or Teflon* Vee packing.

ONE PIECE STEEL HEADS WITH WELDED MOUNTINGS are much stronger than conventional bolted construction and assure squareness of mountings. All mountings are designed to carry maximum cylinder loads with a generous safety margin.

Write for Catalog 900 and the name of your nearest representative.

*DuPont's registered trademark.

Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT... CYLINDERS... VALVES

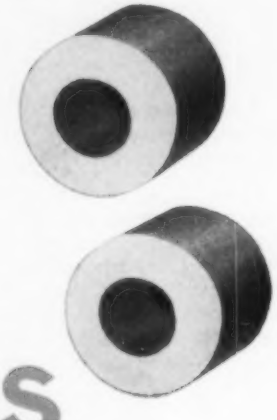
1763 Elston Avenue Chicago 22, Illinois

TEFLON,* KEL-F† MOLDED PARTS COME IN

One is the cost of a *perfect* piece. The other is the cost of an *acceptable* piece.

Garlock's Plastics Division, The United States Gasket Company, will quote both ways. If you require perfection in every sense, then U.S.G. will furnish it. If "leeways" in tolerance or mold finish, for instance, are permissible, then U.S.G. can possibly suggest ways to save 20-25% of the total cost of a molded piece.

Guarantee yourself the right price and right quality every time. No matter how intricate the shape, how thin the wall sections, or how close the tolerances, ask your local Garlock representative to quote on your molded Teflon or Kel-F parts. Call him, or write.



PRICE RANGES

THE GARLOCK PACKING COMPANY, Palmyra, N.Y.
For Prompt Service, contact one of our 26 sales offices and warehouses throughout the U.S. and Canada.

*DuPont Trademark for TFE Fluorocarbon Resin
†M.M. & M. Trademark

United States Gasket *Plastics Division of* GARLOCK

with capacities from ¼ to 3 gpm. 24 models are available. All can be furnished with or without built-in relief valve. From stock. **Tuthill Pump Co, 963 E 95th St, Chicago.**

Circle 320, Reader Service Card

Hydraulic gearmotors . . .

with outputs to 25 hp are offered in five sizes. These reversible motors, developed in England, have speed range of 300 to 3000 rpm. Pressure balancing in simplified design delivers over-all efficiencies up to 80% and contributes to longer life. Cartridge construction eliminates alignment problems. Min starting torque equals or exceeds 65% of running torque. Operate on fluids in viscosity range from SAE 10 to 90. **Berry Hydraulics, Corinth 1, Miss.**

Circle 321, Reader Service Card

Draftsman's straightedges . . .

eliminate disadvantages of steel straightedges on drawing board. Machined from cast acrylic sheet material with optically flat surfaces; are light to move on drawing board and to carry around, are fully transparent, will not soil or mar drawing. Working edges need not be oil-stoned before use. Straightedges are made in ¼ and $\frac{3}{16}$-in. thicknesses. Corners are all rounded and are, as are end edges, chamfered for about 0.030 in. to reduce breakage. Prices for clear units range from $1.90 to $7.15 in lengths of 18 to 42 in. in ⅛-in. thickness; from $2.60 to $8.75 in lengths of 18 to 46 in. in $\frac{3}{16}$-in. thickness. Prices, FOB Detroit. **Dolgorukov Mfg Co, 407 Fisher Bldg, Detroit 2.**

Circle 322, Reader Service Card

Applique material in rolls . . .

for drafting use is made of translucent plastic with fine grain surface that takes pencil, ink or printing. As material makes contact with drafting paper, it becomes completely transparent. Adheres even after long storage. Precut segments of printed roll material are peeled off special backing paper. Each roll contains several hundred duplicate imprints. In addition to special imprints, a group of standard engineering notes and symbols are offered from stock. Drafting material is also offered in sheet form with split backing paper. **Transparent Products Co Inc, Aplika Dept, 324 E 24th St, New York 10.**

Circle 323, Reader Service Card

Multipurpose voltmeter . . .

measures dc voltage, current and resistance over a wide range. Meter measures voltage between 100 microv and 1000 v with accuracy said to be 1% of full scale. Max

(Continued on page 111)

COPPER-COATED Thomas Strip coils, 1¼" wide, are made into the intricate television control part shown in the inset.

Thomas Strip Is Cost-saver at TV Parts Plant

For 20 years, copper-coated Thomas Strip steel was known at Chicago Telephone Supply Corp.'s Elkhart, Ind., plant as the metal to conquer a metal-working plague—scalloping during deep draws.

Now the precision-rolled product of Pittsburgh Steel Co.'s Thomas Strip Division has new claims to fame. It makes possible a one-piece, extruded and stamped mounting plate used to assemble and connect the variable resistor to the television set chassis.

Previously, Chicago Telephone made the grounding plate and mounting bushing in two pieces. The bushing being a relatively expensive brass mounting device, Thomas' copper-coated makes it possible to blank out the intricate part, punch a hole in its center and then extrude the edge of the hole into a load-bearing neck. All this is done at high production speeds with progressive blank and form dies.

In many applications at Chicago Telephone, similar severe demands are imposed. Examples:

- **THICKNESS TOLERANCE**—As tight as ±.0005". A variation of ±.001" can cause a potentiometer cover to be off .005".
- **UNIFORM TEMPER**—Some parts are made at speeds up to 400 units per minute. Any wide hardness deviation results in troublesome forming variations.
- **SHEARABILITY**—Punched and blanked parts have tolerances so snug that the slightest burr prevents proper assembly.
- **UNIFORM COPPER COATING**—Copper acts as a necessary die lubricant and a base for nickel plating. When the mounting plate was made from plain steel, die life ranged from 40,000 to 62,000 units. Now, with the more difficult mounting plate, die life averages 250,000 units between regrindings.

Whether you need dimensional accuracy, surface, temper, aid to die life, chemistry or design and production advantages, you'll find them in Thomas Strip. It is a controlled rolled steel, plain or in a variety of electrolytic coatings of copper, brass, nickel, zinc, tin, chrome and lacquer with a full range of tempers, widths and finishes. Thomas Strip also is available with an attractive but durable pattern rolled right into its surface. For details, contact any sales office. Do it today.

Thomas Strip® Division

Pittsburgh Steel Company

Grant Building · Pittsburgh 30, Pennsylvania

District Sales Offices:

Atlanta	Detroit	Philadelphia
Chicago	Houston	Pittsburgh
Cleveland	Los Angeles	Tulsa
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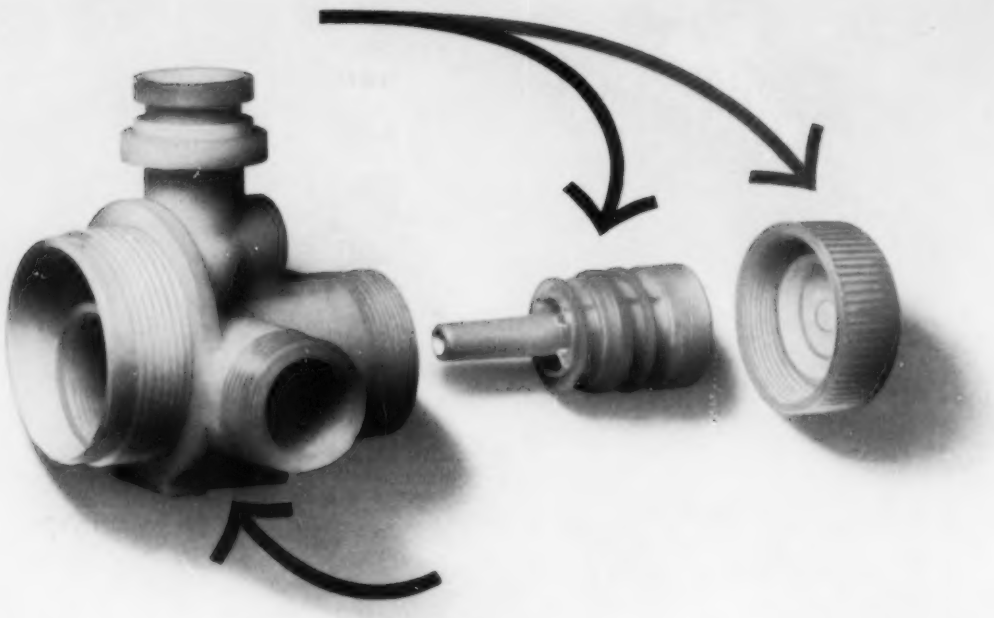
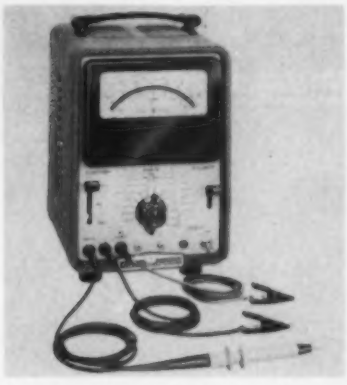


Chicago Molded parts improve performance, cut costs 3 ways

These molded nylon parts compose a unique Venturi valve unit used to regenerate the mineral bed of the Culligan Automatic Water Softener. Previous valve bodies were brass. By switching to injection molded thermoplastics, performance and durability were improved . . . material cost cut, machining and finishing eliminated. To function properly, exacting tolerances were vital. And the valve's $\frac{3}{8}$" diameter outlet had to be formed without parting lines—inside and out. Any irregularity would harm the Venturi system vacuum. We had the answer, and production capacity to mass produce the parts as specified. *Your job* may be smaller or very large . . . may require a different plastic . . . compression or transfer molding. Our forty years of custom molding know-how and a complete range of press facilities can come up with *your* right answer—can recommend the material and method of utmost value to you. Call or write . . . no obligation.

CHICAGO MOLDED
PRODUCTS CORPORATION
1024 North Kolmar Avenue, Chicago 51, Illinois



full-scale sensitivity is 1 milliv. Measures current from 0.1 microamp to 1 amp with reported accuracy of 2% of full scale. Max full-scale sensitivity is 1 microamp. As ohmmeter, it measures resistance of 0.02 ohm to 5000 megohm on wire sections of 6 in. min. Instrument controls consist of a function selector, a 13-position range switch and a lever-type polarity switch. Voltmeter circuit employs photo-chopper in place of mechanical vibrator. Input is floating, with resistance increasing from 10 megohm on the 1-milliv range to 200 megohm on ranges above 100 milliv. Current and voltage ranges have 10-db sequence. Priced at $350. **Hewlett-Packard Co, 275 Page Mill Rd, Palo Alto, Calif.**

Circle 324, Reader Service Card

Sensitive, portable balancer... for in-place balancing and vibration analysis of all types of assembled machinery, is adjustable from below 10 millionths of an in. to over $\frac{1}{16}$ to $\frac{1}{8}$-in. amplitude of vibration. In operation, pickup converts amplitude of vibrations electromagnetically into electrical impulses that are amplified in electronic unit, which triggers strobe light to freeze image of rotating part and pinpoint trouble source. Angle of unbalance is indicated through stroboscope and amount of vibration appears on direct-reading meter. Resonance pickup automatically filters out extraneous vibrations and can be placed on machine part. Probe is attached to pickup unit and held against part. Unit operates on 115-v, 60-cps, single-phase current. Lists at $1195. **Stewart-Warner Corp, 1826 Diversey Pkwy, Chicago 14.**

Circle 325, Reader Service Card

NEW! 2-WAY

control versatility

REMOTE SWITCHING...PLUS
OVERLOAD...AND
SHORT CIRCUIT PROTECTION

SOLENOID OPERATED BREAKER

Compact...Low-Cost...Simplified Circuitry

Here's the answer to sure, low-cost remote panelboard control for lighting and branch distribution circuits... for limited service starters and contactors. Choice of signal?... timer, automatic, pushbutton.

Electrically-operated dual-solenoid actuators. Mechanically-held for failure-proof service with standard breakers. Protection includes thermal overload and short circuit. Trip-free design.

Interrupting capacities to 10,000 amp rms!

2 pole – 3 pole – 4 pole

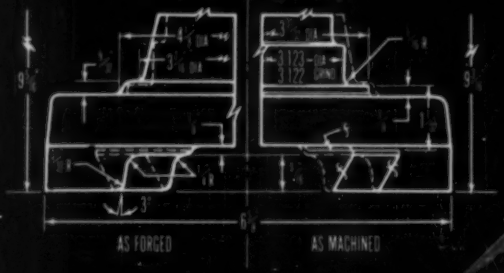
240 – 480 – 600V AC
125 and 250V DC

State control voltage and current ratings when requesting quotations.

THE Lake Shore ELECTRIC CORPORATION

306 Willis Street BEDFORD, OHIO

Metal Forming Ideas



How upsetting saves metal – reduces machining

Key part in a new multi-purpose farm tractor by Minneapolis-Moline was a steering link pedestal which involved unusual requirements both as to its final performance and actual production.

On the performance side, the design of forged pedestal gives Minneapolis-Moline customers a three-in-one tractor. In a matter of minutes change-over of three different front ends is made through the dovetailed groove.

From the production standpoint, the part was unusual in both shape and design—included a dovetailed groove in its head, plus an off-center shaft.

The requirement: A metal and a forming method which could produce this unusually shaped key component to meet all requisites on strength, lightweight, and yet afford maximum savings on both metal and machining of the forging.

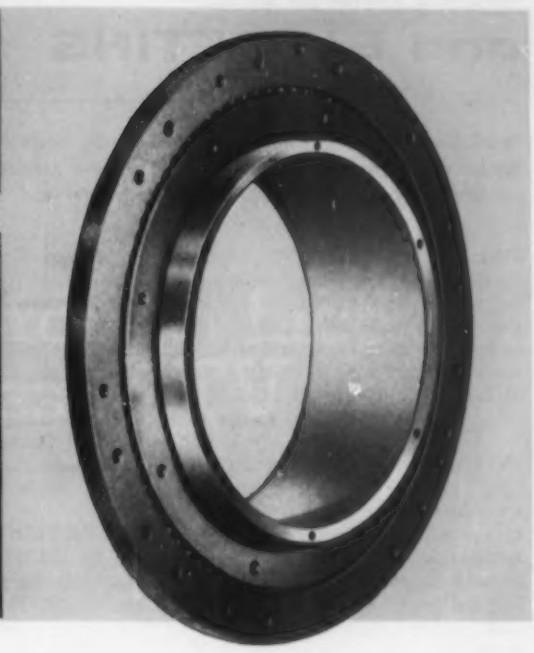
The "Task-Forging" team at COMMERCIAL, working closely with Minneapolis-Moline engineers, proved that upset forging, despite the fact that it is rarely considered for the forming of off-center shaft components – particularly when they also involve a dovetail groove swaged in one end like this one —could best meet this requirement on every count. The steering link is now being successfully produced as an upset forging on a 6 in. upsetter by COMMERCIAL.

As an upset forging it is more than strong enough to do the job. The controlled grain flow and efficient metal distribution afforded by upset forging assures maximum tensile and torsional strength. Equally important, there are no hidden, inside faults in the finished part—sound, dense, non-porous, forged metal from center-to-surface eliminates rejects, makes machining more effective.

At a finished weight of 22½ lbs. (after machining) the steering link is easily light enough. And since the weight of the upset forging (before machining) was 27 lbs., the important savings in both metal and machining made possible by the inherent close tolerances of the upset forgings produced by COMMERCIAL are obvious.

Whether you're looking for help in the forming of a new component or only considering an improvement in the forming of an already existing part, "Task-Forging," COMMERCIAL's new metal forming service—backed by over 30 years of metal forming experience, plus specialized equipment which includes 1½" thru 8" upsetters – may be able to help you. Address inquiries to Commercial Shearing & Stamping Company, Dept. G-26, Youngstown 1, Ohio.

COMMERCIAL
shearing & stamping



The HEART of this
Brunswick-Balke-Collender AUTOMATIC PINSETTER

is an Aetna Ball Turret Bearing

. . . chosen for accuracy, dependability and unfailing service on an exceptionally intricate piece of equipment—a marvel of design and production ingenuity.

The entire mechanism revolves on this one bearing. After collecting and elevating the pins, they are positioned in a revolving "turret" where they are held until the last pin is received. As this last pin drops through the center of the Aetna bearing, it activates the catch mechanism and pins are released into position in the "deck." The "deck" in turn sets the pins upright with correct spacing and arrangement on the alley bed ready for bowling.

Quick, dependable performance is the key to the success and widespread adoption of the Brunswick Pinsetter. It must function perfectly, steadily, accurately—game after game, day and night—without maladjustment, breakdown or delay—and it is in just such service that Aetna Bearings prove their stamina, perfect workmanship, accuracy and dependability. Despite the fact that the pins vary slightly in weight, the Pinsetter continues to perform smoothly and accurately on its main Aetna Bearing which remains in correct alignment at all times and operates quickly, smoothly, unfailingly load after load.

Equal performance and dependability are built into your products when you specify Aetna Ball and Roller Bearings. Call your local Aetna representative listed in the Yellow Pages of your Classified Telephone Directory, or write direct for General Catalog and Engineering Manual.

AETNA BALL AND ROLLER BEARING COMPANY

Aetna

DIVISION OF PARKERSBURG-AETNA CORPORATION • 4600 SCHUBERT AVE. • CHICAGO 39, ILL.

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CIRCLE NO. 113 READER SERVICE CARD 113

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 123.

FINE-PITCH PRECISION GEARS—Catalog, 96 pp. Dimensions, catalog number, specifications and prices for stock gears. With dimensional drawings. Covers line of 48 through 200 pitch to AGMA precision classes 1 and 2. US Gear Corp, 81 Bay State Rd, Wakefield, Mass.

Circle 331, Reader Service Card

PNEUMATIC PRODUCTS – Catalog 900b, 81 pp. Discusses principles of compressed air processing, fundamentals of operation for various products, and specifications. Comprehensive catalog includes illustrations, dimensional drawings and general engineering information. C A Norgren Co, 3400 S Elati St, Englewood, Colo.

Circle 332, Reader Service Card

VULCANIZED FIBER AND LAMINATING PLASTIC MATERIALS—Engineering handbook, 40 pp. Lists general physical properties and specific uses for various materials and engineering reference material for use by design engineer. Fully illustrated. Spaulding Fibre Co Inc, Tonawanda, NY.

Circle 333, Reader Service Card

CLAMPS, SUPPORTS, BRACKETS AND SHIMS—Engineering Design Manual TA210G, 88 pp. Includes labor- and cost-saving installation techniques for all types of electronic, hydraulic and mechanical harnessing problems. Over 400 illustrations are used in perspective, with weight charts on popular items. Has illustrated index. Also includes preprinted sketch sheets. TA MFG Corp, 4607 Alger St, Los Angeles 39.

Circle 334, Reader Service Card

ELECTRICAL CONNECTORS—Bulletin 2711, 48 pp. Discusses design features of environmental connectors, describes line of plugs and receptacles, gives specifications and performance data and contains line drawing illustrations. Crouse-Hinds Co, Syracuse 1, NY.

Circle 335, Reader Service Card

INDUSTRIAL AND MOTOR CONTROLS—Booklet, 12 pp. Illustrates and describes magnetic contactors, starters and reversing contactors, together with diagrams of enclosures and dimensions. Also covers starter-relay combinations, combination starters and enclosure. B/W Controller Corp, 2211 E Maple Rd, Birmingham, Mich.

Circle 336, Reader Service Card

PLASTER-MOLD CASTINGS – Brochure, 8 pp. Covers selections of materials, processes and design considerations in vacuum-cast plaster-mold castings. Universal Castings Corp, 5821 W 66th St, Chicago 38.

Circle 337, Reader Service Card

WATER-TIGHT LIMIT SWITCHES—Bulletin EM-5912, 16 pp. Describes new, heavy-duty line of limit switches that are also oiltight. Three fold-out sheets permit engineer or layout man to trace units directly onto layout at half-scale. Each sheet lists specifications, current ratings and mounting styles on front; parts list on reverse. Electrical Mfg Div, National Acme Co, 170 E 131th St, Cleveland 8.

Circle 338, Reader Service Card

SELF-ALIGNING ROLLER BEARINGS—Condensed catalog 59A, 32 pp. Covers line of self-aligning roller bearings. Presents design, specifications, lubrication, seals and installation information. Compiled to help in selection of proper equipment. With cutaway views, dimensional drawings and photos. Chain Belt Co, Sales Promotion Dept, Milwaukee 1.

Circle 339, Reader Service Card

FHP ELECTRIC MOTORS—Catalog, 12 pp. Describes and illustrates basic line of fhp motors, blowers and special products. With dimensional diagrams, standard ratings and performance data. Redmond Co Inc, Owosso, Mich.

Circle 340, Reader Service Card

MOLYBDENUM-CONTENT STAINLESS—Brochure, 8 pp. Contains information on composition ranges, mechanical properties, corrosion resistant properties and high-temperature mechanical properties of wrought and cast stainless alloys. Sales Promotion Dept, Cooper Alloy Corp, Hillside, NJ.

Circle 341, Reader Service Card

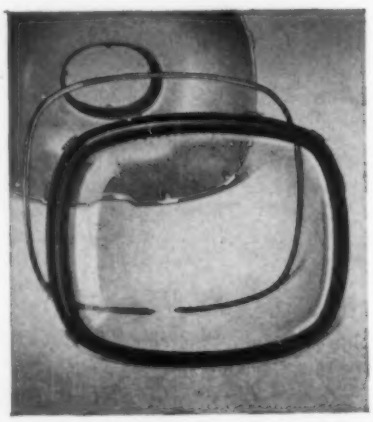
DRAFTING EQUIPMENT – Catalog GC-59, 24 pp. Covers drafting-room accessories, blueprint filing units, cabinets, drafting and drawing tables, tracing

(Continued on page 116)

1 PROTECTIVE FACE for picture tube housing is a one-piece injection molding of Tenite Butyrate plastic. Dark strip around edge is a "frame effect" created by painting the inside border. Molded for Philco by Buffalo Molded Plastics, Inc., Erie, Pa.

Tenite Butyrate has two jobs in new Philco TV sets

2 DECORATIVE TRIM STRIP that conceals the joint between Butyrate face plate and rear shell of tube housing is an extrusion of Tenite Butyrate. Strip is extruded with an aluminum foil insert to simulate a metal molding. Trim strip, post-formed to conform to shape of housing, is supplied by Anchor Plastics Co., Inc., Long Island City, N.Y.



Philco takes the picture tube out of the chassis ...protects it with a face of tough Butyrate plastic

The new line of Philco Predicta TV sets is another example of how Tenite Butyrate plastic can be used to improve the design and sales appeal of products.

Thanks to the toughest "face" on TV—a one-piece molding of clear Tenite Butyrate, tinted to minimize glare—Philco now features a picture tube that is dramatically set apart from the chassis.

Although many factors contributed to the choice of Butyrate here, the basic consideration was its inherent toughness, since a separated picture tube would be exposed to extra hazards.

In Butyrate, Philco engineers found a material with all the toughness and impact resistance they needed. Moreover, this Eastman plastic also satisfied the other requirements involved... light weight... optical clarity... resilience... easy moldability... high dielectric strength.

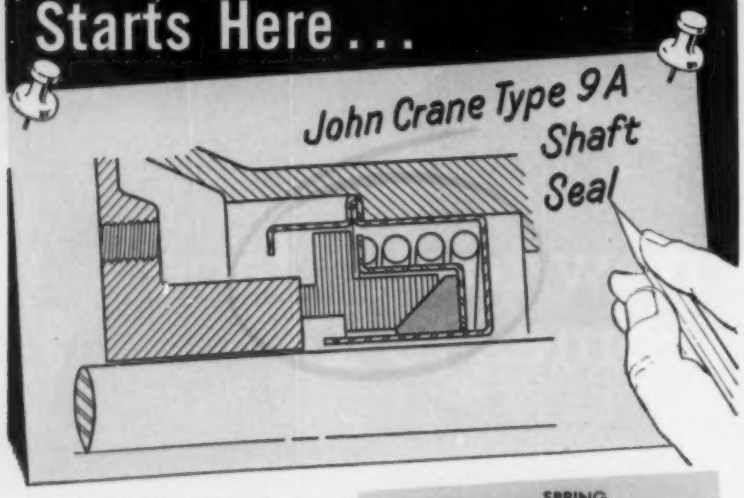
Incidentally, the color that imparts an eye-easing tint to the face is part of the plastic itself. Philco designers were able to specify the color desired, and Tenite molding compound was supplied to the molder in an exact match. Result: the tinting color is an integral part of the face, not merely a coating that might wear, chip or flake off.

If you are designing or redesigning a product, consider Tenite Butyrate whenever you need a truly tough plastic. Easy to mold, extrude or vacuum-form, Tenite Butyrate is available in clear and colored transparents, translucents, opaques, metallics, and variegations to match your specifications. For more information, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

TENITE
BUTYRATE
an Eastman plastic

CIRCLE NO. 115 READER SERVICE CARD

Sealing Corrosive Liquids Starts Here...

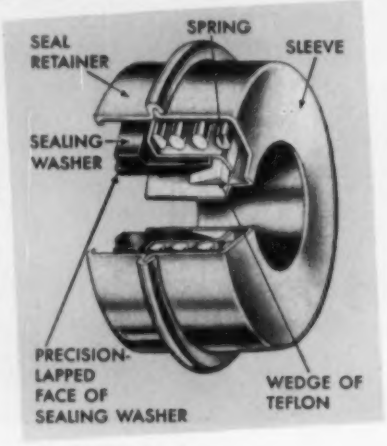


This cartridge-type shaft seal designed for the production line is engineered for:

(1) positive sealing of many industrial chemicals and solvents (note the Teflon* sealing wedge);

(2) leakproof handling of inflammables and toxics;

(3) operation over a wide temperature range from −120° to +500°F., pressures to 150 psi.



It offers the Original Equipment Manufacturers these important advantages:

(1) low unit cost through mass production;

(2) fast, one-piece installation through cartridge construction;

(3) equal efficiency on both low or high speed applications, because seal does not rotate with shaft.

The 9A Shaft Seal can be of stainless steel, monel, brass or other materials adapted to stamping and forming—depending on the service requirement.

Get full details. Request Bulletin S-205-3 from Crane Packing Co., 6445 Oakton Street, Morton Grove, Illinois *(Chicago Suburb)*.
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

*DuPont Trademark

CRANE PACKING COMPANY
OFFICES IN ALL PRINCIPAL CITIES

equipment, tubes and reference tables. Gives dimensions and general descriptions. Stacor Equipment Co, 295 Emmet St, Newark, NJ.
Circle 342, Reader Service Card

AIR AND VACUUM PUMPS—Catalog 359, 16 pp. Gives construction details, dimensions, capacities, new performances and installation information. Covers rotary positive air and vacuum pumps, gas boosters and air motors. Leiman Bros Inc, 102 Christie St, Newark 5, NJ.
Circle 343, Reader Service Card

WELDED AND WELDLESS CHAIN—Bulletin 59, 28 pp. Chain sample book illustrates most sizes of 17 types of chain. Actual-size illustrations, recommended uses and working load limits are included, together with trade sizes and numbers, material size, weight per 100 ft, number of links per ft, finish and packing information. S G Taylor Chain Co Inc, Hammond, Ind.
Circle 344, Reader Service Card

SELF-SEALING COMPONENTS AND FASTENERS—Catalog 359, 12 pp. Lists military specifications, features and applications for line of single-unit, high-pressure seals and fasteners. Presented with engineering drawings and specifications in tabular form. Fasteners are also described through charts, tables and line drawings. APM Sales Corp, 252 Hawthorne Ave, Yonkers, NY.
Circle 345, Reader Service Card

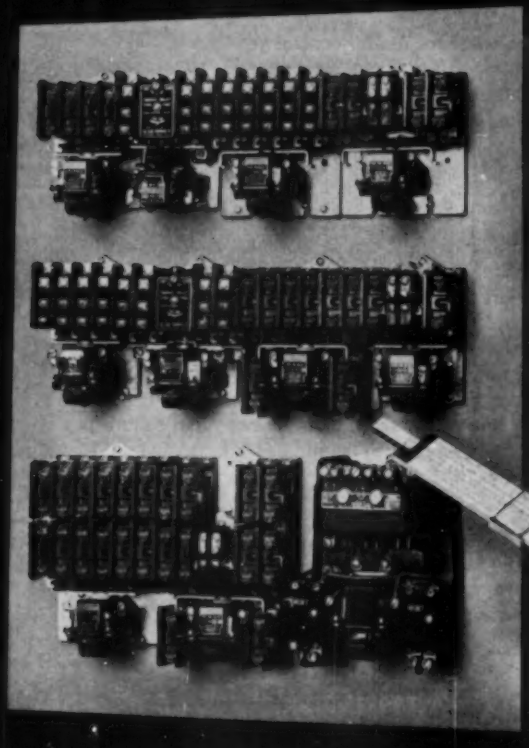
SILICONE PRODUCTS—Bulletin CDS-129A, 8 pp. Highlights major silicone products and their uses. Among those described are rubber products, including room-temperature-vulcanizing silicone rubber—also polishes, electrical insulation, water repellents, lubricants, release and antifoam agents. General Electric Co, Waterford, NY.
Circle 346, Reader Service Card

ULTRAHIGH-STRENGTH STEEL—Booklet, 12 pp. Discusses composition, properties and performance of 300-M steel, which offers usable tensile strength of 290,000 psi at 0.40% carbon level. Charts and tables are based on diversified testing. International Nickel Co Inc, 67 Wall St, New York 5.
Circle 347, Reader Service Card

AIRCRAFT TUBING—Handbook A-2, 70 pp. Revised and up-dated version describes seamless aircraft tubing, carbon and alloy steels. Covers definitions, military and AMS specs, sizes, tolerances, sampling, testing, marking, machining, packing, heat-treating, properties and mill practices. Presented with charts, tables

(Continued on page 120)

WHY SPACE IS
FRONT-PAGE NEWS...



Compact Clark Relays control 72 circuits from panel area smaller than a newspaper

In this day of space exploration and space economy, it's news—front page news—when you can get 72 separate, controlled circuits all on a panel no larger than 15" x 20".

Clark Controller, with the most complete and integrated line of control relays available today—convertible pole, latch, universal pole, and time delay—does it! And only Clark offers such a wide range of operation, so many contacts, in a panel area of such small size.

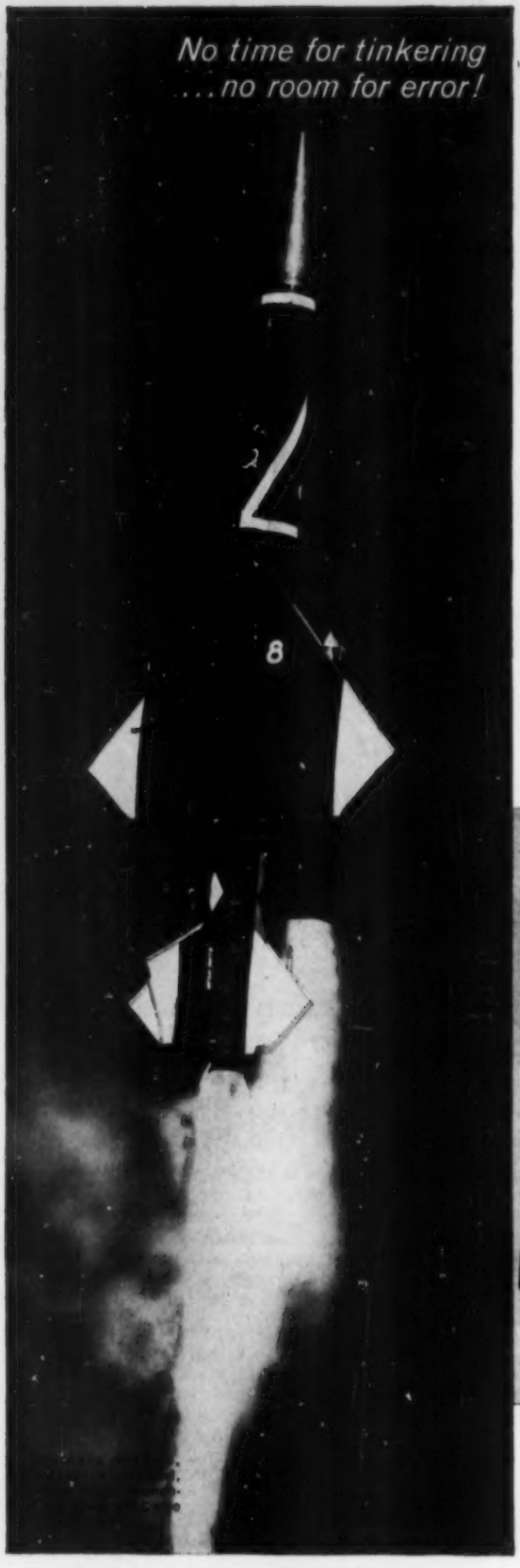
Shown mounted here with the Clark Size 1, Type "CY" Starter are 10 compact Clark Relays which include four time delay contacts (two normally open, two normally closed), 52 instantaneous contacts (14 normally open, 14 normally closed, and 24 convertible), plus 16 latching contacts (all convertible).

The same engineering leadership and superior workmanship that made Clark Controller the *standard of quality* for controls in heavy industry, is inherent in the broad line of Clark Relays for modern panels.

The "modular construction" of all Clark "PM" Relays insures integrated uniformity, compactness and flexibility. Functional alignment in mounting results in neater, more uniform panels and most efficient utilization of valuable space. And because "PM" relays are available in a wide variety of pole combinations, providing up to 14 contacts on a single relay, you can control more circuits—save on relay requirements.

For more information on the complete line of Clark "PM" Relays which is making space-saving headlines, contact your nearest Clark Controller sales office or distributor. Or, write direct to Clark Controller for free bulletins.

The
CLARK CONTROLLER *Company*
Everything Under Control • 1146 E. 152nd St. • Cleveland 10, Ohio
IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO



Fafnir Ball Bearings help keep Bomarc missiles "on tap"... and on target!

Used in the outboard rudder control gear box of the Boeing Bomarc, Fafnir ball bearings meet several important design requirements for Indiana Gear Works, designers of this vital missile component.

Fafnir prelubricated and shielded ball bearings and bearings with Plya-Seals, for example, provide positive, built-in protection against contaminants. These bearings remain trouble-free, require no servicing, help keep the Bomarc ready to go at moment's notice.

Uniform high quality is another must. Fafnir quality control insures bearings that consistently meet exacting tolerance and dimensional requirements, installation after installation.

Your own design problem may not involve missilery. But if it calls for ball bearings, look to Fafnir. You'll find the diversity of line and breadth of experience that assure precise answers. Write The Fafnir Bearing Company, New Britain, Connecticut.

Rudder control gear box, developed by Indiana Gear Works of Indianapolis, incorporates both Fafnir contact-type Plya-Seal ball bearing, extra-light series (left) and Fafnir double shielded type.

FAFNIR
BALL BEARINGS

Look alikes... until you look closely!

At first glance, all microfilm images look pretty much alike. But enlarge them in a film reader or in paper facsimile form, and you'll see the difference:

In the image produced under the Recordak Precision Engineering Drawing System, you'll note the pinpoint definition throughout . . . the remarkably uniform background.

New Recordak techniques and controls, perfected in three years of research and development, have made this possible—a 35mm negative that faithfully reproduces every detail of the original drawing. Duplicates, made from this negative, in film or paper form, are just as accurate.

As a result, drawings and negative and positive prints of all sizes—old or new, clean or soiled—can be photographed without loss of detail on 35mm film. Ends need for costly, larger size films.

Mounting each of these Recordak images on its own aperture card provides an active drawing file that takes 95% less space . . . saves reference and filing time. Extra reference copies—on film or paper—can also be made at lowest cost.

And, of course, this Recordak System can be correlated with existing mechanized filing and duplicating systems for greater savings!

Free booklet gives all the facts on this Recordak System available nation-wide through Recordak branch offices or Recordak Microfilming Dealers.

"Recordak" is a trademark

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(Subsidiary of Eastman Kodak Company)

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SPLICED

DIE CUT

MACHINE CUT

HAND CUT

PRECISION GROUND

Channels or chicken pluckers . . . washers or weatherstrips . . . you name it and we'll make it! And we'll produce it to meet your most precise design specifications! Stalwart offers you a complete rubber parts *service* . . . Rubber Engineers develop your special compound from natural, synthetic or silicone rubbers . . . Laboratory Technicians pre-test actual performance . . . our own completely equipped Tooling Department produces the necessary extrusion dies . . . skilled Production Personnel operate the latest rubber machinery for maximum economy, dependable delivery . . . and *our* Quality Control Department protects *your* interests! This means you get higher quality at a lower cost . . . the result of nearly 40 years of fabricating experience! To solve tough rubber parts problems . . . cut assembly costs, *specify Stalwart.*

Write today for complete information.
Ask for your copy of Stalwart Catalog SR-59.

STALWART RUBBER COMPANY

166 Northfield Road • Bedford, Ohio
Manufacturing facilities in
Jasper, Georgia and Bedford, Ohio

120 CIRCLE NO. 120 READER SERVICE CARD

and drawings, where applicable. Ohio Seamless Tube Div, Copperweld Steel Co, Shelby, Ohio.

Circle 348, Reader Service Card

DIGITAL INSTRUMENTATION—1959 Catalog, 12 pp. Covers 32 instruments and accessories with features, descriptions, specs and applications. Computer Measurements Co, 5528 Vineland Ave, North Hollywood, Calif.

Circle 349, Reader Service Card

ENGINES AND POWER UNITS—Catalogs BU-528 and BU-531, 8 pp each. Presents design, engineering and performance capabilities of G-149 and G-226 units. Includes center-spread cross-sectional drawing with descriptive marginal notes. Engine-Material-Handling Div, Allis-Chalmers Co, Milwaukee 1.

Circle 350, Reader Service Card

THREADED TUBULAR RIVETS—Catalog 201, 8 pp. Design data, general features, application information and examples of actual use. Includes cross-section drawings, application diagrams and dimensional views. Tubular Rivet & Stud Co, Quincy 70, Mass.

Circle 351, Reader Service Card

DIMENSIONAL STANDARDS FOR RIVETS—Guide, 4 pp. Contains standards data on all major classes of semi-tubular rivets. Includes in chart form such information as body and head diameters, head thicknesses and radii and hole diameter and depth figures. Tubular and Split Rivet Council, 53 Park Pl, New York 7.

Circle 352, Reader Service Card

HIGH-PRESSURE GAGE—Brochure, 6 pp. General specifications of high-pressure gages and individual descriptions of each of four basic models. Gives dimensions and materials information for dial, case, stem and pressure ratings. Illustrated with cutaway and dimensional views. Rochester Mfg Co, 100 Rockwood St, Rochester 10, NY.

Circle 353, Reader Service Card

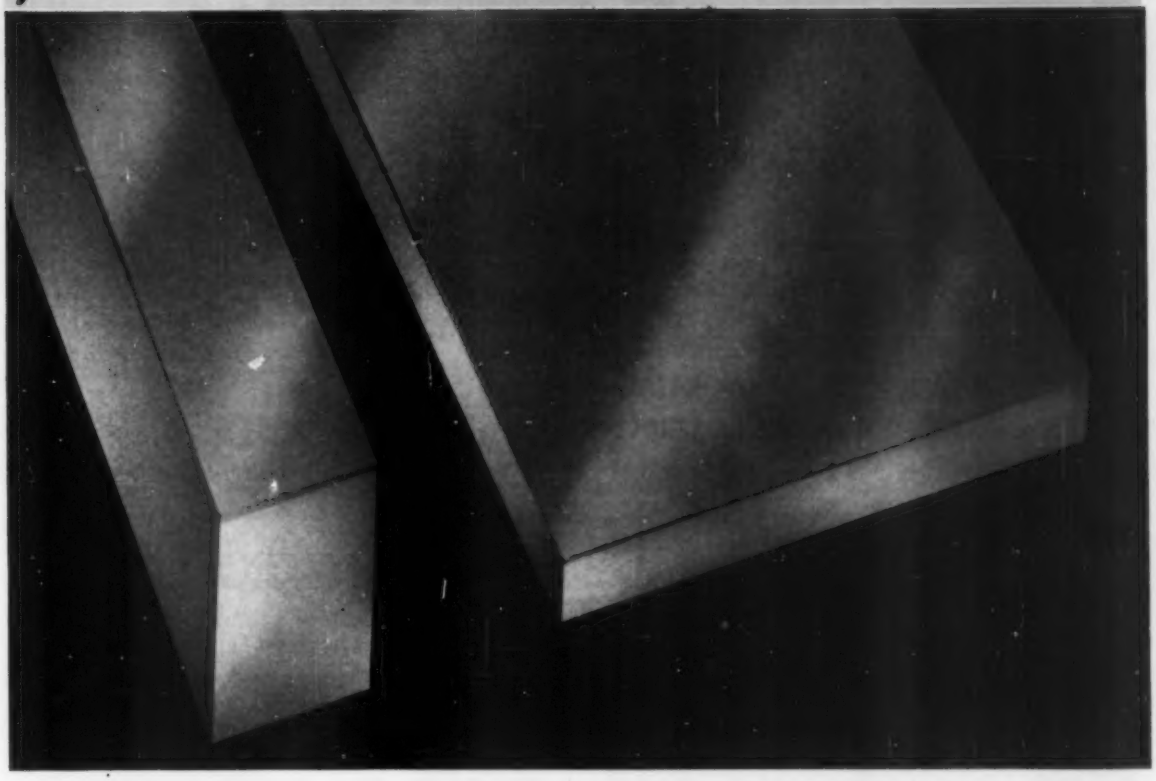
BERYLLIUM COPPER ALLOYS—Data sheet series, 12 pp. Information on beryllium copper 10, 25 and 165 alloys. Chemical analysis, physical constants and mechanical properties of each alloy are described; heat-treating procedures are outlined and illustrated and working instructions are given for fabricating. Pennrold Div, Brush Beryllium Co, 501 Crescent Ave, Reading, Penna.

Circle 354, Reader Service Card

CADMIUM, LEAD AND TIN PRODUCTS—Bulletin, 4 pp. New uses for

(Continued on page 123)

Another! LAMINA BRONZE-PLATED PRODUCT



New Lamina Wear Plates Last Longer, Cost Less!

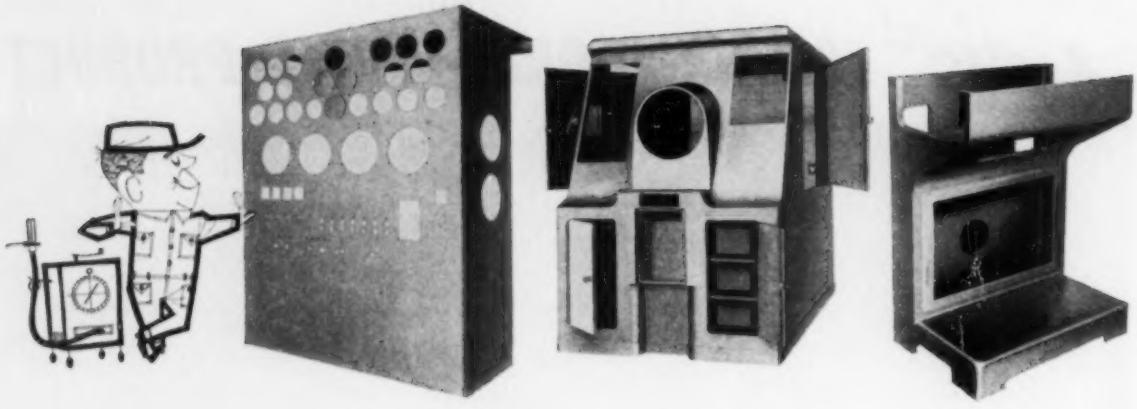
Now . . . save money and get better performance wherever you have sliding contact between flat metal parts! The principle of bronze electroplated on a steel backing originated with Lamina Bronze-Plated Guide Pin Bushings. Proven during countless millions of punch press hits, it is now being used successfully to produce flat wear plates.

This new concept in wear plate design combines the low cost, ready machinability and solid backing of steel with the long-wearing, non-seizing, free-running properties of a copper-tin bronze alloy. Lamina Bronze-Plated Wear Plates are flat, parallel, and can be easily machined to suit your application. Standard sizes available from stock. End costly wear problems and reduce expensive downtime now! Write for complete information.

Lamina
DIES AND TOOLS, INC.
P.O. BOX 31, ROYAL OAK, MICHIGAN

Manufacturers of Lamina Guide Pins, Bronze-Plated Bushings and the Finest Precision Progressive and Lamination Dies

CIRCLE NO. 121 READER SERVICE CARD 121



LITTLEFORD CAN SPEED UP PRODUCTION BY FABRICATING YOUR WELDMENTS, BASES, CABINETS or INSTRUMENT MOUNTING STRUCTURES

The fabricating specialists at Littleford not only shear, form, bend and weld such metals as Carbon Steel, Stainless Steel, Aluminum, Monel, Nickel, Everdur, and Inconel . . . but are masters in solving any fabricating problem that may confront you. Units of unusual nature, shapes and sizes . . . designed to do unusual functions, pass through Littleford's modern plant daily.

Whenever you require any type of fabricating work, remember Littleford has the experience and equipment to produce the finest product at the lowest possible cost. Send your blue-prints or sketch for estimate . . . it costs no more for the finest . . . Littleford Quality Fabricating.

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LITTLEFORD
Bros., Inc.
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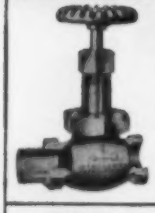
insure permanent leakproof joints in copper or brass piping

Fairbanks THREADLESS Valves



"Fairco-Braze" Threadless Valves for silver brazed joints. Cut costs, speed installation of piping systems handling steam, hot or cold water, oil, compressed air, carbon dioxide, Freon and many other liquids and gases.

The silver brazed connection withstands tension, compression, torsion and vibration to a far greater degree than any other type joint.

Solder End Threadless Valves for soldered joints. Get perfect seal of valves for type "K", "L" and "M" copper tubing with Fairbanks Solder End Threadless Valves. Simple, quick installation provides a smooth, compact, full flow assembly that has high resistance to corrosion.

Full line of Fairbanks Solder End Threadless Valves —Globes, Gates and Checks—have an unusually wide application range.

YOURS ON REQUEST: Fairbanks Valves Catalog, complete with cutaways, details, and specifications describing these Fairbanks Threadless Valves.

THE **FAIRBANKS** COMPANY
393 LAFAYETTE STREET NEW YORK 3, N. Y.
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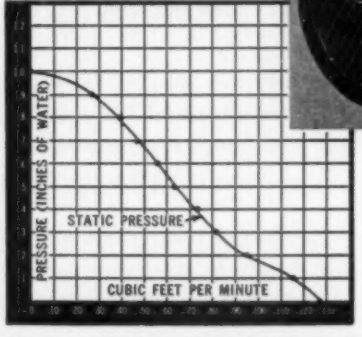
MORE THAN 3000 HOURS at 125°C ...and still running!



NEW Tube Axial Blower

Here's a miniature tube axial blower that withstands the most rigid MIL specifications! Tests at 125°C and under extreme shock and vibration conditions, have exceeded 3000 hours, with no sign of failure. The motor is EAD's rugged, 400-cycle 208-volt induction motor, run at a constant speed of 7200 rpm. Write for complete information on this peak-performance blower assembly.

EAD EASTERN AIR DEVICES, INC.
Subsidiary of Norbute Corporation
381 CENTRAL AVE., DOVER, NEW HAMPSHIRE

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cadmium, lead and tin are explored. Detailed analysis of cadmium is included, as well as information on rolling and extrusion of mill products by this company. White Metal Rolling and Stamping Corp, 92 Moultrie St, Brooklyn 22, NY.

Circle 355, Reader Service Card

MINIATURE SPEED REDUCERS–Bulletin 97, 4 pp. Describes series 8 and 9 fixed ratio units, available in over 400 fixed ratios. Includes torque, speed, hp and backlash information. Metron Instrument Co, 432 Lincoln St, Denver 3, Colo.

Circle 356, Reader Service Card

COUNTING INSTRUMENTS – Brief catalog and pricelist, 4 pp. Describes electric counters, including dustproof and hermetically sealed models, switches for actuating electric counters, stroke counters, revolution counters, dozen counters, coin counters, lineal measuring counters, coil winding counters and automatic batch counters. Pic Automation Controls Div, General Controls Co, 8072 McCormick Blvd, Skokie, Ill.

Circle 357, Reader Service Card

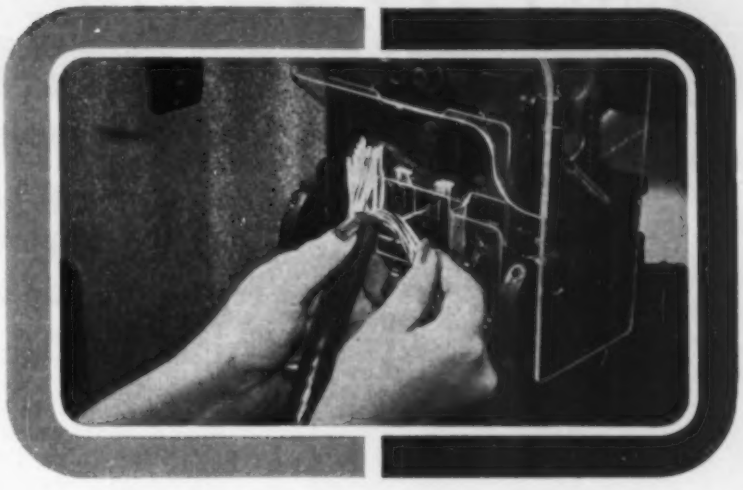
Letterhead Requests Only

Manufacturers who publish following literature ask that requests for copies be made on company letterheads.

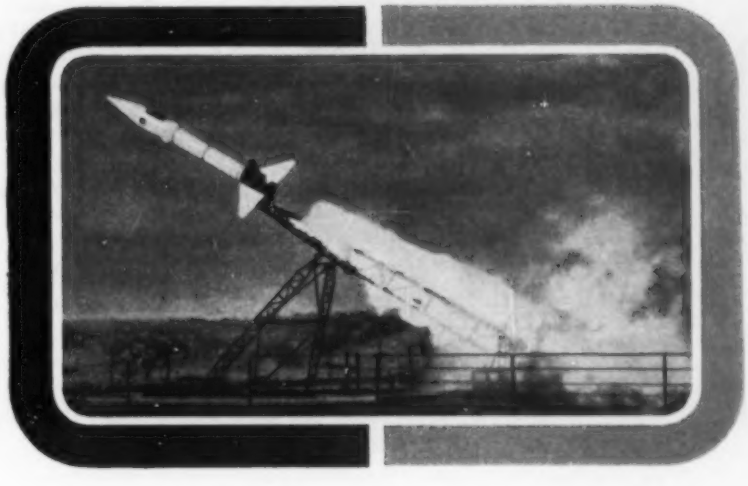
ROLLER BEARINGS–Engineering manual SF-90, about 100 pp. Dimensions, capacities, general specifications for standard and special bearings. Includes typical applications. With dimensional drawings. Roller Bearing Co of America, Sullivan Way, West Trenton, NJ.

"Good Grief, man! Don't you read the Sunday Comics? That's already been done!"

Circuit Terminations Made Here



Do Not Fail Here



Each click of the dies in this A-MP Automachine indicates the completion of another top quality termination. This completely mechanical "crimp" means that there will be no variations in quality, no failures in service. The A-MP terminal actually becomes a homogeneous part of the wire end, supporting it against vibration, resisting corrosion, and affording the soundest electrical performance.

The A-MP Automachine literally "mints" these attachments at the rate of thousands per hour . . . and at a minimum cost to you. Time and time again, AMP has proven that its method costs less and assures higher reliability than any other termination method.

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for PRECISION . . . specify

ACIPCO

CENTRIFUGALLY SPUN STEEL TUBES

For almost 80 years, Morton Manufacturing Company of Muskegon Heights, Michigan, has been progressively building bigger and better machine tools.

This ultra-modern turning and boring mill is 27 feet x 22 feet x 40 feet high, and weighs 525,000 pounds. Load capacity is 120,000 pounds. Driven with 210 horse-power, it is the first machine of its type wherein the work remains stationary.

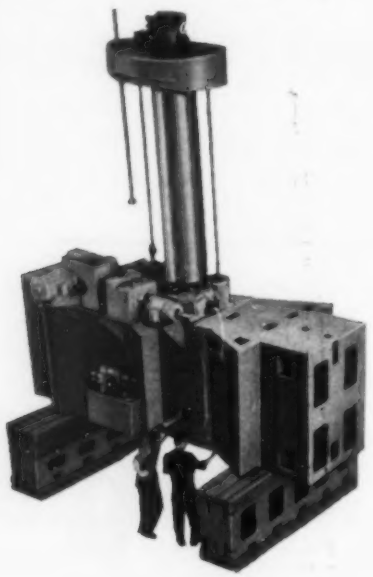
Because of the herculean task this machine must perform, each component must be capable of precise performance under extreme loads. Morton wisely selected ACIPCO centrifugally spun steel tubing for the gigantic quill which houses and guides the rotary spindle. This tube is 24″ in diameter, 3″ in wall thickness and 17′6″ long.

ACIPCO centrifugally spun tubes have a dense, non-directional grain structure that has extra-ordinary strength and durability, and is more easily machined to close tolerances.

Whatever you may have in tubular applications, call on ACIPCO for perfect dependability. Our technical and manufacturing competence will serve your exacting needs.

MORTON

Morton Manufacturing Company, of Muskegon Heights, Michigan, is a leading manufacturer of heavy duty machinery for the machine tool industry. Boring mills; drillers, planers, as well as special machine tools for national defense and the development of new processes are among their products.



ACIPCO Centrifugally Spun TUBES

SIZE RANGE: Lengths up to 410″ have been produced to meet modern machinery requirements. OD'S from 2.25″ to 50″; wall thicknesses from .25″ to 4″.

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special analyses.

FINISHED: As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.

SPECIAL PRODUCTS DIVISION

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ACIPCO

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Rating Fluid-control Valves
Author charts directions in which ratings can be simplified. June 22 *Circle E 87*

Nylon's Tough New Rival
Design data on a new plastic-rubber blend costing half as much as nylon. June 8 *Circle E 86*

Dwell Position of Three-Gear Drives
New equations aid in design of this intermittent drive. June 8 *Circle E 85*

Roundup of Assembly Methods
16 pages of illustrated how-to's on all the ways to put parts together, distilled from previous articles in Product Engineering. June 8 *Circle E 84*

For a Tight-gasketed Joint
Gasket behavior with different flange metals and fluctuating temperatures. May 25 *Circle E 83*

Batteries for Higher Energy
Can power packs become only 1/10 as heavy as the best now available. May 25 *Circle E 82*

(Continued on page 127)

"We'll give the job to Hendricks . . . Don't tell him it can't be done . . . He's just ignorant enough to do the job . . ."

Design Uniform lift into equipment with DUFF-NORTON WORM GEAR JACKS

Many designers find a ready answer to precise control of linear motion in machinery or equipment with built-in Duff-Norton Worm Gear Jacks.

They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66DD.

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P. O. Box 1889 • Pittsburgh 30, Pennsylvania
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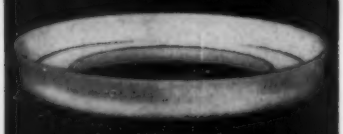
Single Turn Back-up RINGS . . .

ALL THE NEW MILITARY SIZES — MS-28774, MS-28777 and MS-9058.

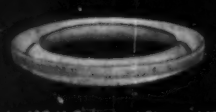
Accurately machined to assure you the fullest utility range and life of your equipment.

Only HALOGEN offers "MEMORIZED" TEFLON

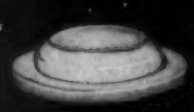


Style 310 Piston Cups

Style 614 V Rings



Style 410 U Cups and Blocked Vees



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Halogen cylinder packing is known for operating successfully and efficiently over the widest temperature and pressure ranges . . . because they are "MEMORIZED".

This is an EXCLUSIVE process which makes the packing lip "remember" the size of the rod or cylinder . . . and keeps it in sealing position, regardless of temperature variations.

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Simplify Design Problems

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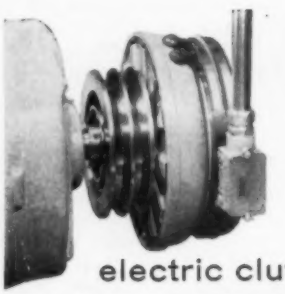
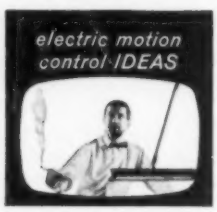




electric clutches with "dial tuning" for

stepless torque modulation

For fast, smooth load pickup or accurate synchronization of multiple drives, potentiometer controlled torque of Warner electric clutches is the answer. Torque buildup can be varied from job to job without complexity or machine downtime. By increasing or decreasing resistance in the power circuit, clutch engagement can be varied over a wide range during the first few seconds of engagement. Also, with torque of multiple clutches adjustable in stepless increments through a central control system, it's possible to engage or disengage any number of power drives at exactly the same instant. "Dial tuning" Warner electric clutches let you apply the velvet touch on any job. Write for Catalog P-52.

WARNER

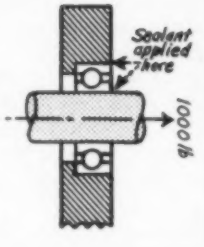
Warner Electric Brake & Clutch Co.
Beloit, Wisconsin

Edwin F. Oblinger, Chief Engineer, Parker Sweeper Company, says:

"WE THREW OUT PRESS FITS FOR BEARINGS...

"We used interference fits to prevent bearing races from turning in the gear box of our 4HP Turbosweeper. Maintaining close tolerances was a constant headache. If the fit was loose, the race would slip and fret the surfaces; if the fit was tight, the race would deform and bearing life would be shortened. Then we discovered LOCTITE Liquid Sealant would do away with the need for press fits. We opened up the tolerances for both shaft and housing and used a slip fit, filling the clearance with LOCTITE. The bearings are retained with a force equal to the customary interference fit, but we've reduced rejected parts from 8% to less than 1% and reworked parts fell from 20% to 0! Field reports are excellent."

LIQUID SEALANT ... replaced interference fits and opened up tolerances almost 0.002 in. on shaft and housing for this ball bearing assembly. Load of over 1000 lbs. is needed to break bond.



LOCTITE is a penetrating liquid that hardens only after being confined between closely fitted metal parts. In the absence of air, the sealant hardens into a strong, heat and oil-resistant bond. The hardening action may be accelerated by heating.

LOCTITE eliminates the need for interference fits on bearings, sleeves, shafts and studs... locks nuts to bolts, seals pipe and tubing joints. Write for literature and free sample.

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AMERICAN SEALANTS COMPANY
119 Woodbine St., Hartford 6, Conn.
Stocked by bearing and industrial distributors

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"I think he was trying to tell me something."

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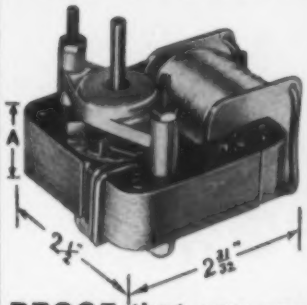
Smooth Power
AC MOTORS

MILLIONS
now in use...



PROOF that you can
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Meet an all-around performance champion. GI's husky, versatile Model "A" motor. **Proved dependable millions of times over,** it's the power choice of the nation's great-name manufacturers ... setting an amazing performance record in countless applications from phonographs to kitchen fans to pumps. If dependability is your aim, Model "A" is your motor!

MODEL "A" two-pole shaded pole motor available in various lamination thicknesses. Precision constructed for reliable, long hard usage. Perfectly balanced for smooth, quiet, operation.

MODEL	HP 3000 RPM	LOCKED TORQUE in./oz.	MAXIMUM TORQUE in./oz.	FREE SPEED RPM	A
A-3-CW A-3-CCW	1/500	0.7	1.1	3360	5/8"
A-4-CW A-4-CCW	1/350	1.0	1.4	3300	1/2"
A-5-CW A-5-CCW	1/180	1.7	2.7	3430	5/8"
A-6-CW A-6-CCW	1/130	1.9	3.3	3430	5/8"
A-7-CW A-7-CCW	1/100	2.1	3.8	3500	5/8"
A-8-CW A-8-CCW	1/90	2.5	4.5	3480	1"
A-9-CW A-9-CCW	1/70	2.7	5.3	3520	1 1/16"
A-12-CW A-12-CCW	1/60	3.0	6.5	3500	1 1/2"
A-14-CW A-14-CCW	1/50	3.1	7.0	3490	1 5/8"
A-16-CW A-16-CCW	1/45	4.0	7.5	3490	2"

Standard shaft diameter .1817, 1/4" shaft available if desired.

Write today for catalog sheet and quantity-price quotations.

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Pressures to 2500 PSI

Output from 1-60 GPM

DOWTY

Pressure Balanced

Hydraulic Gear Pumps

Features: Pressure balanced self-compensating design minimizes internal leakage . . . unique cartridge construction . . . high output to weight ratio . . . 14 sizes in 4 model groups . . . superior performance over wide range of operating speeds, pressures, temperatures and oil viscosities.

Applications: Road building machinery, farm equipment, fork lift trucks, power shovels, presses, machine tools, dump trucks and many more. Developed and proved in England and now available in the United States from:

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Tangents...

Sooner or Later, One Forgets

Just after World War II, I hired a young man who had been a mathematics expert at Los Alamos. He undoubtedly knew all the mathematical shortcuts there were, particularly in nuclear physics. But he had one strange characteristic—he was no good at ordinary arithmetic. His first expenses account included 17 errors in addition.

The same situation has existed with many men who have their degrees in English or journalism—they cannot spell. They can quote the rules for extremely complex constructions, but they violate the most basic of the rules in their own writing.

And the same situation exists also among engineers, many of whom have excellent knowledge in their specialties, but somewhere along the line have forgotten the fundamentals—if they ever really knew them. Witness the older engineer who tries for a professional license – and flunks the schoolbook part of the exams. Or the chief engineer who remembers calculus but can no longer turn it to his will. Or the engineer who was worried about changing a cracked elbow in the cooling-water line of his cruiser, because the boat weighed six tons. He forgot that the elbow was only two inches below the water line, so the head was just 2 in., and the weight of the boat didn't matter.

The point is, of course, that even mental tools become rusty if they're not used frequently, and kept well oiled between times. And it's hard to remember, in the stress of larger decisions, handling personnel, making reports, and the like, that the simpler "tools" are rusting away from disuse.

Perhaps this is of no real importance, because the older engineer who undertakes executive or other work will probably not need these tools again. He may be acutely embarrassed at times by his loss of them—as is a bandmaster without his shako or the doctor without his stethoscope. They are the visible symbols of the engineer, so he should have them with him.

More important, however, is the attitude of mind that characterizes the engineer—the ability to analyze and consider. This was probably in his makeup as one of the factors that set his mind in the direction of engineering in the first place. His training merely sharpened it, directed it. It is so inherent that he will never lose it. And for the older engineer, this is the vital element, even though it isn't superficially apparent. As one chief engineer said to me: "I can hire the calculus, the mechanics, the thermo and the rest of the book skills for less than it costs to keep me."

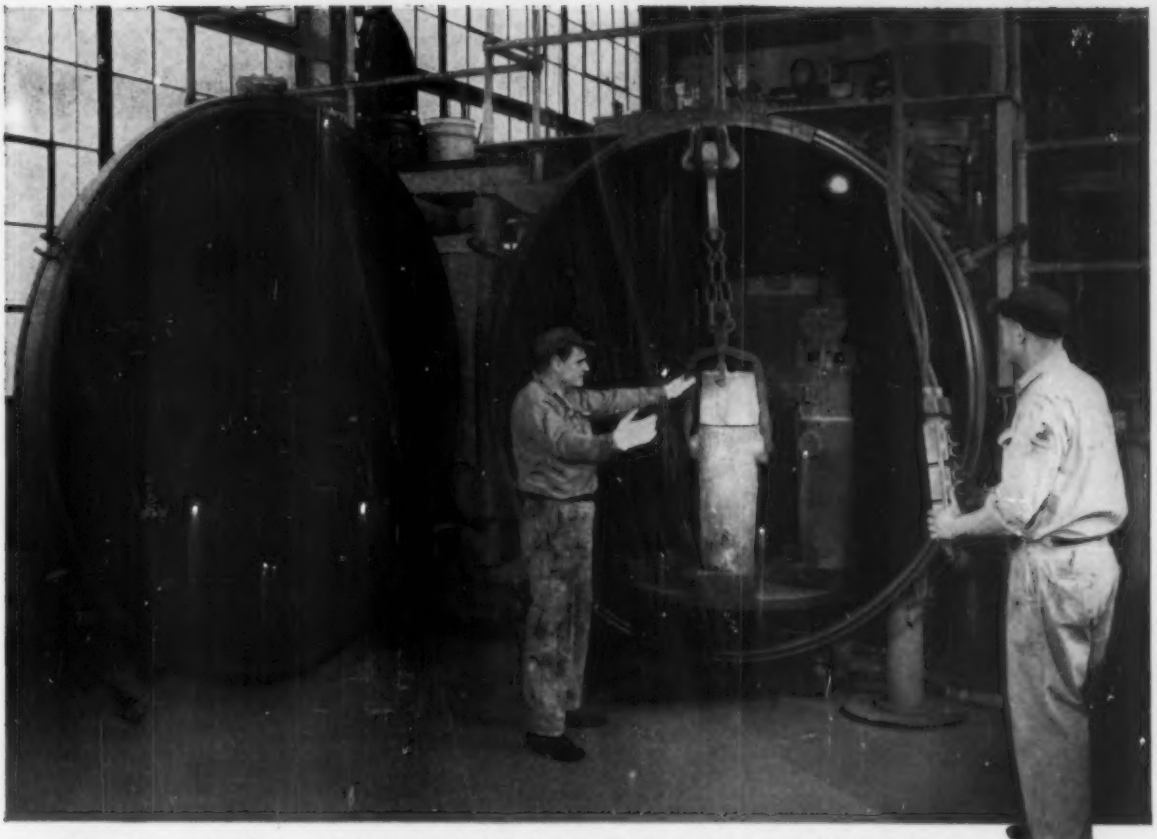
He was right. The judgment and experience that he had came high. And the rate of development of engineering knowledge in such areas as physics and electronics make his training in those subjects obsolete anyhow in a few years unless he devotes an untoward amount of time to them. He can at best hope to have a superficial knowledge of the specialties—a knowledge of when they are important. If he has much more than that, he becomes a specialist himself.

Some time back, I came across a poem, fashioned by some whimsical unknown in the style of W S Gilbert, about a chemist. It may be comforting to other old-timers. Here it is, with a few changes to suit the engineer:

The Modern Doctor Technical

I am the very pattern of a modern
Doctor Technical.
I send to all the journals my remarks
and views polemical.
I've studied mathematics 'til I think in
terms vectorial
And scorn the plodding soul who seeks
for molecules pictorial.
The calculus is food for babies; I love
a complex variable
And state a simple law in terms the
layman thinks are terrible.
I can talk of relativity and space-time
for a month or more
And integrate elliptically to terms the
(n + 1)th or more—
And yet my hand and mind are seized
with palsy and paralysis
When I essay that dreadful task—a
common stress analysis.

(Continued on page 132)



NOW EXCLUSIVELY VACUUM MELTED KARMA High Resistance Alloy THERLO Glass Sealing Alloy

This dramatic "first" in the manufacture of nickel alloys by Driver-Harris has been achieved by expanded vacuum melting capacity. It is still another example of our continued leadership in producing electrical and electronic nickel alloys of the highest purity.

D-H vacuum melting produces alloys of higher ductility and tensile properties. These are achieved by greatly reducing inclusions, especially oxides and nitrides. Other direct benefits are elimination of gas, not only from the surface but from the entire mass, and general improvement in the electrical, electronic and mechanical properties to meet critical specifications.

For additional information about Karma, Therlo and the other 130 high-nickel alloys manufactured by Driver-Harris, write for a copy of the D-H Alloy Manual.

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The temperature coefficient of superior KARMA resistance wire has been improved to less than ±10 parts per million from —60°C. to +125°C. Higher stability and linearity are added to these important properties.

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Improved workability is the major result of vacuum melting THERLO . . . the long established cobalt, nickel, iron alloy for sealing to hard or thermal shock resistant glass. THERLO also:

- Produces a permanent vacuum-tight seal with simple oxidation procedure
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- Is readily machined and formed—deep drawn or spun
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- Is available as rod, wire, strip, sheet foil—and in special shapes

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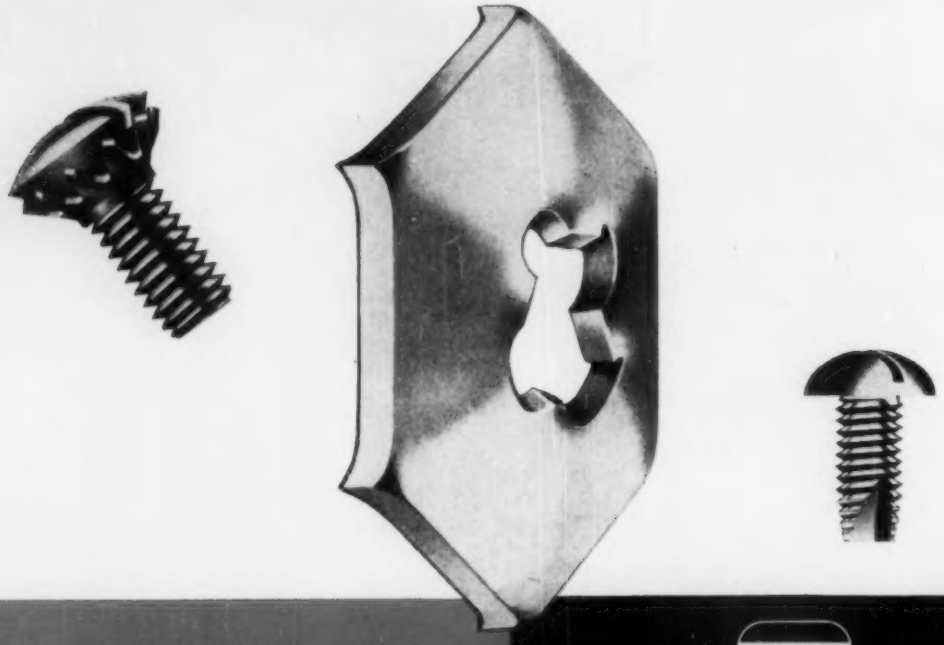
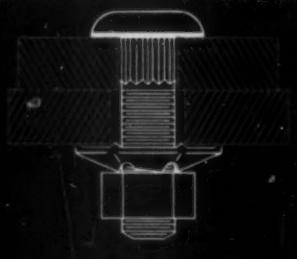


HOW TO SELECT COST-SAVING

fasteners for heavy duty applications



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How to Fasten Securely to Avoid Shifting

Where considerable tension in the fastening is needed to keep the parts from shifting, the Shakeproof®-developed Pyramidal Lock Washer* should be used. This washer spans large clearance holes — provides tension needed to keep parts securely fastened and in alignment.

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For want of the right fastener, man-hours and money are often needlessly lost! It's vital to economical assembly line production to specify fasteners for each application that will do a fast and effective job *every* time. Fasteners engineered by Shakeproof assure maximum locking, reduce handling, and provide many additional functions that save assembly time, reduce production costs and improve your product's quality.

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This cylinder for a hydraulic press was cast and machined in a Blaw-Knox Steel Foundry. Weight—231,000 pounds.

Blaw-Knox Steel Foundries have machine capacity to handle the most unusual product requirements

Planing, turning, milling, or boring the most unusually dimensioned casting is no problem in a Blaw-Knox Steel Foundry. There you will find planers up to 15 feet × 15 feet × 36 feet, lathes with an 84 inch swing, and planer type milling machines up to 6 feet × 6 feet × 25 feet. In the same machine shops, you will find the smallest precision tool room equipment.

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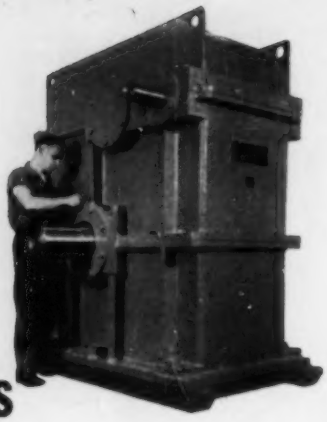

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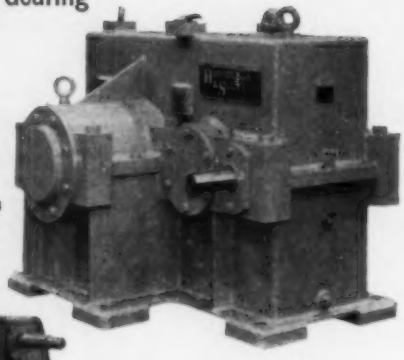

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I outdistance Bohr and Summerfeld in
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spins heretical—
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When in Met Lab I'm faced with a
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Yet still the old-time worker shakes his
sides with vulgar merriment
When I confess how I detest per-
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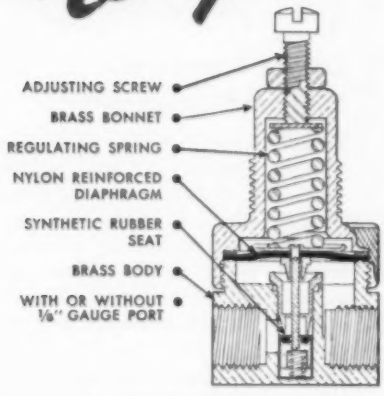

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DESIGN ABSTRACTS

Design Criteria for Oscillating Plain Bearings

Load-life and friction characteristics of sleeve-bearing materials were tested under conditions simulating airframe operation. Charts relating bearing load and wear to life in terms of cycles of oscillation were constructed from data obtained and are included. Frictional characteristics that developed in this testing program were also studied.

"A Study of Design Criteria for Oscillating Plain Bearings," Glaeser and Allen, Battelle Memorial. Presented at American Society of Lubrication Engineers Los Angeles Lubrication Conference, 84 E Randolph St, Chicago.

Flexible Torsional Couplings

Static torque-deflection relationships for couplings with nonlinear characteristics are examined. A procedure is given for using static hysteresis loops to determine equivalent elastic constants and damping coefficients under different cycles of load.

"Static and Dynamic Behavior of Flexible Torsional Couplings with Non-linear Characteristics," A. Seireg, Falk Corp, ASME paper 59-SA-8, 29 W 39th St, New York 18.

Critical Speeds of Ballbearing-supported Shaft

Author describes two kinds of critical speeds induced by a slight difference in diameter of balls in a ballbearing. Two modes of vibrations determined by bearing dimensions are described. Causes of critical speeds and behavior of vibrations are discussed.

"On Critical Speeds of a Shaft Supported by a Ballbearing," Toshio Yamamoto, Nagoya University, Japan, ASME paper 59-APM-12, 29 W 39th St, New York 18.

Thermal Stresses in Plates

Thermal stresses in plane of moderately thick elastic plates are expressed as function of two plane stress functions; the normal stress in thickness and the temperature. The conditions under which corrections in two-dimensional, plane-stress solutions

(Continued on page 139)

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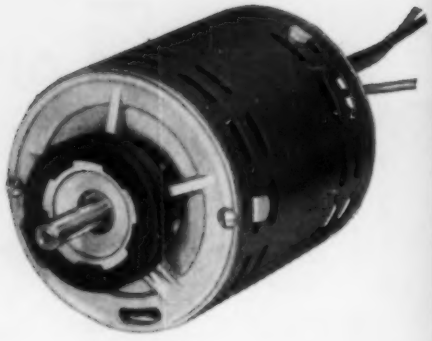

this R & M motor puts the "Drive" in IBM electric typewriters!

Almost twelve years have elapsed since International Business Machines Corporation used its first R&M motor to power its electric typewriters. Since then R&M has supplied thousands upon thousands of these special motors for IBM's world-wide typewriter trade. In order to meet varying electrical conditions the world over, they are now supplied in 21 different voltages and frequencies.

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A lot of fingers have gone over the keys since R&M produced its first IBM typewriter motor, but we still subject each IBM power unit to 100% inspection. Moreover, we constantly work with IBM—and all our customers—to improve our motors and to adapt them to the ever-changing requirements of customers' products.

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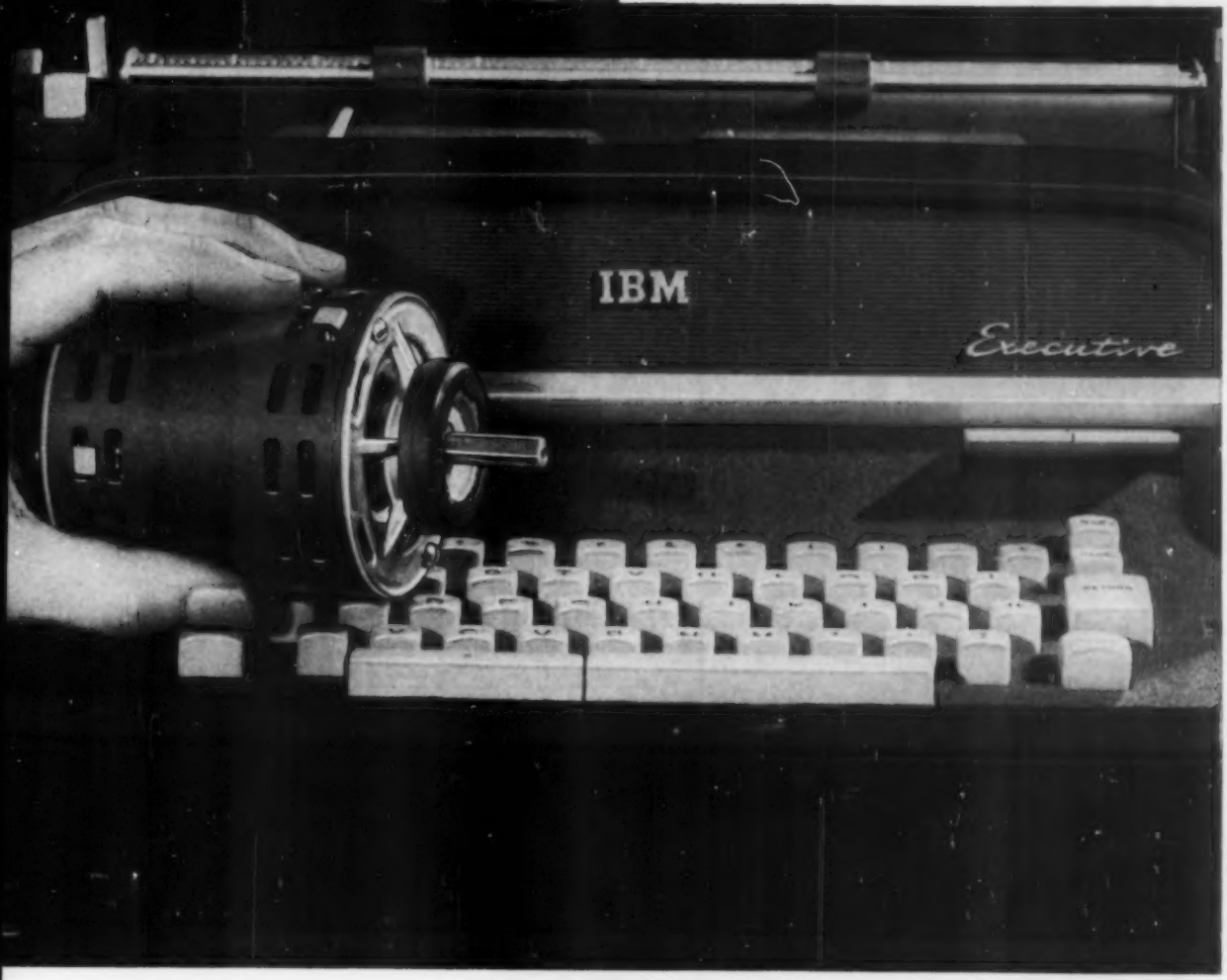
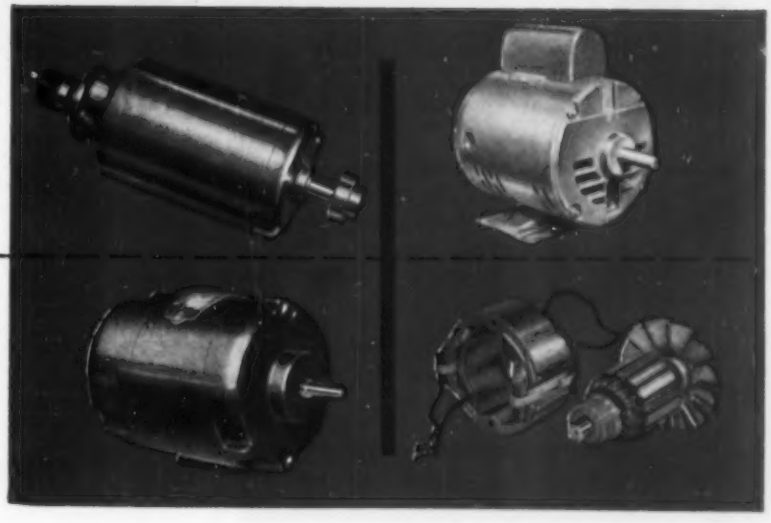


At left, Retractable Capstan Motor . . . shaft of this special R&M fractional HP motor rotates and also moves axially. Manufactured for IBM's 727 Magnetic Tape Unit.

At right, Standard Fractional HP Motors . . . a wide range of types, sizes and mountings for DC, single or polyphase AC; all standard voltages and frequencies.



At left, Standard Universal Motors . . . ratings from 1/60 to ½ HP. Choice of end, pad or foot mountings to permit design versatility. Custom designs also available.

At right, Series Motor Parts . . . precision-made series, universal or polyphase high-cycle motor parts. All types and sizes engineered to your requirements.

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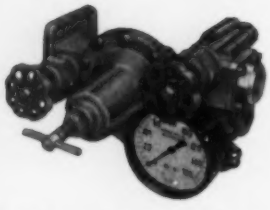

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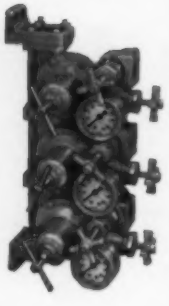
Concentrates air controls by combining line shut-off valve, pressure regulator, blowdown valve, check valve, gage shut-off and gage. Eliminates leakage and external connections. Easily maintained. Saves much space and downtime. Units interchangeable. Can be multiple-mounted by use of headers.



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2 double-acting hand pumps, 2 gages, 2 relief valves, and 2 needle bleeder and shut-off valves, completely manifolded, for missile ground support equipment. All valve adjustments readily accessible.

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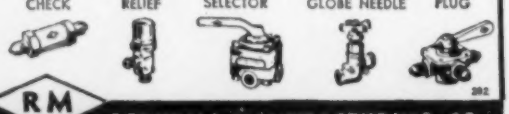
Pilot-operated relief valve, check valve, flow control valve and by-pass valve combined to facilitate test-stand operation. Gives quick, easy control of both flows and pressures.

● **MANIFOLD COMPONENTS,** engineered for a specific application, is a Republic specialty. Modern design demands a new dimension in space, weight, installation, and service. Let our valve specialists solve your specific compacting problem.



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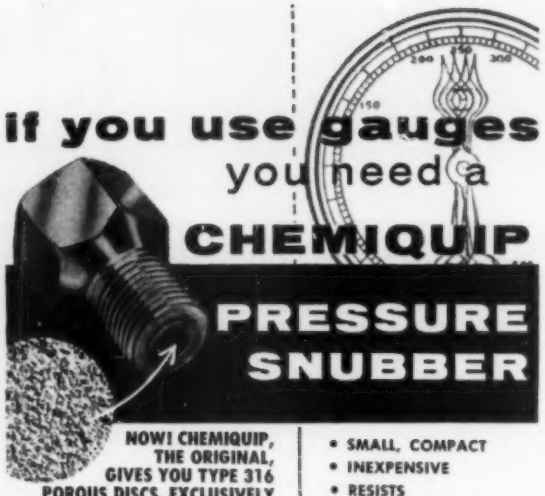

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do and do not require correction because of temperature gradients are discussed.

"Thermal Stresses in Moderately Thick Elastic Plates," B E Gatewood, ASME 59-APM-7, 29 W 39th St, New York 18.

Equipment Reliability

Discusses an approach to reliability and failure probabilities, classifying latter into infant mortality, random failure and wear-out. Relationship between economy of operation, first costs and reliability as manifested in finished products are examined.

"A New Search for Criteria of Equipment Reliability Evaluation," I J Karassik, Worthington Corp, ASME paper 59-SA-2, 29 W 39th St, New York 18.

Stepped-thrust Bearings

Problem of the stepped thrust bearing is considered, but, where normally volumetric continuity is assumed, equations are solved assuming mass continuity–variation of density is also considered as well as effect of stepped discontinuity on load-carrying capacity and coefficient of friction. Computed theoretical curves illustrate importance of density on bearing operation and, in part, explain results on this subject that have already been published.

"Density Variation Effects in Stepped-thrust Bearings," C F Kettleborough, ASME paper 59-APM-19, 29 W 39th St, New York 18.

"Golly, Mr. Barton, it must be pretty frightening to know all there is to know."

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Brevel "F" motors have **fully-enclosed gear trains;** provide maximum protection of gears against dirt.

Designed to give maximum power transmission at lowest noise level by use of specially cut helical gears. Optional features—brake, clutch, and cooling fan—make it suitable for a wide variety of applications. Like all Brevel Motors, this new "F" Motor provides reliable power at low cost. *Write, wire, or phone today for Catalog 29R.* You will receive information on Brevel's complete line of small gear head motors.

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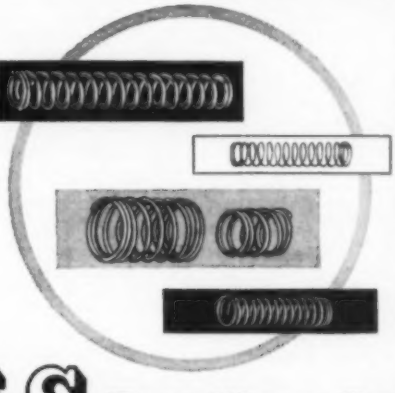

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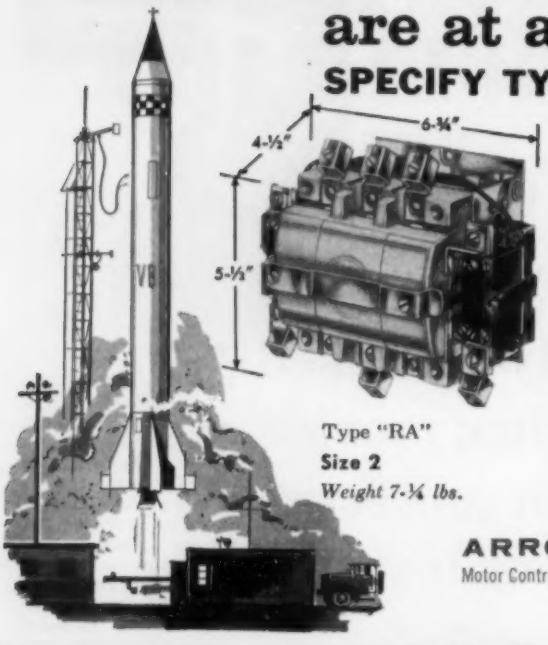

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NEW BOOKS

Silanes in Hydraulic Fluids and Lubricants

PB131889. HAROLD W ADAMS and GEORGE BAUM, Wright Air Development Center. Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 27 pp. $1.

This report, based on work done in the Materials Lab from November 1955 to March 1957, describes a new class or silane base stocks with possibilities for use as high-temperature turbojet engine oils and hydraulic fluids. The physical and chemical properties of the alkyl and alkyl-aryl silanes show them to possess good thermal stability up to 650 F, good lubricity and marginal oxidative stability at 500 F. Silanes are reported to be useful as base materials for a 0 to 500 F engine oil or a 0 to 700 F hydraulic fluid. Some types can be used as bases for low-temperature (—100 to 400 F) greases.

Evaluation data is given for about seven silanes in these areas: ignition temperature, flashpoint, firepoint, pour point, viscosity, thermal stability, oxidation, metal wear, rubber swell, foaming, vapor pressure.

The full title of this paper is "Laboratory Evaluation of Silane Fluids as Potential Base Stocks for Hydraulic Fluids and Lubricants."

Hydraulic Seals for Temperatures to 500 F

PB 131762—WADC Technical Report 57—76. CHARLES W GALLOWAY, Douglas Aircraft Co Inc. Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 141 pp. $3.

Test reports are given on seals and packings for use in high-temperature hydraulic systems utilizing either OS-45 or MLO-8200 fluids at operating temperatures of 400 F and 550 F respectively. In general, two polymers performed with considerable promise at 400 F. At 550 F no seals were found to be acceptable although one polymer, Viton A, exhibited good thermal resistance at that temperature.

The full title of this paper is "Evaluation of High-temperature Hydraulic Seals to Temperatures of 550 F—Part I, Mechanical Evaluation."

Electrical Measurements

ARTHUR W SMITH. Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36. 6 x 9, 307 pp. $7.50.

This textbook is a complete revision of original book (1914); it gives the intermediate student of physics and engineering some facility in handling work in electricity and magnetism from both the theoretical and the experimental standpoint. Prepares him for further work in the fields of advanced electricity and electronics. Topics covered are: evaluation of errors, review of elementary electrostatics, ammeter and voltmeter methods, circuit theorems and their applications to dc circuits, the current galvanometer, ballistic galvanometer, measurement of resistance—

(Continued on page 141)

The Wheatstone bridge, potentiometer and standard-cell methods—measurement of power, magnetic effects of electrical currents, Faraday's law, mutual induction, self-induction, and magnetic measurements, transient currents, alternating current, solution of ac circuits by means of complex notation, measurement of capacitance, self inductance, mutual inductance, frequency and electronics. Sets of problems follow each chapter.

Guide to the Literature of Mathematics and Physics

NATHAN GRIER PARKE III. Published by Dover Publications Inc, 920 Broadway, New York 10, NY. 5 x 8, 436 pp. $2.49.

This guide lists more than 5500 key works under 120 subject headings such as Projective Geometry, Geometric Optics, and Cosmic Rays. The titles are cross-referenced and the subject classifications are based on those used by *Mathematical Reviews*, making it easy to build one's own bibliography. Whenever a foreign language title appears, any translations are also listed. If there is no English translation of a Russian work, for example, the guide indicates if there is one in German.

Lists of indexes, documentary reproductions, abstracts and other bibliographic aids have been included to aid as a research tool for students and professionals.

Machine Tools for Engineers

CHARLES R HINE. Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36, NY. 9 x 6½, 445 pp. $7.75.

Few, if any, products are directly or indirectly made without machine tools. So visualizing the tool can make product designs more effective. This book is useful because it assembles a complete treatment of all the machine tools including some of the latest electromachining equipment. It is a handy reference and worth its price.

One detraction, however, is the mediocre editing. Too many of the pictures repeat the same story or tell none at all. The text suffers from ambiguous terms like "decrease in tolerance" which have to be read twice in context to discover whether it means a closer dimensional tolerance or a wider one.

Polymers and Resins

BRAGE GOLDING, PhD. Published by D Van Nostrand Co, Inc, Princeton, NJ. 716 pp, 6 x 9, $15.

In one comprehensive volume this new book covers theory, chemistry, properties, manufacture, fabrication, and application of all commercial polymers and resins. Plastics, fibers and elastomers receive up-to-date and accurate treatment. Emphasizing commercially useful polymers, the author classifies substances by chemical type and similarity rather than by physical end use and avoids grouping of chemically unrelated substances which happen to be useful in a particular field (elastomers, for example).

For engineers, chapters on fabrication and applications are especially valuable. Presented carefully and in detail, they enable the reader to make intelligent guesses about the composition and probable method of fabri-

(Continued on page 145)

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Arrow-Hart Type "RA" Motor Controls feature the advanced design "Right Angle" mechanism, with the magnet operating through a simple bellcrank mechanism. This provides a mechanical advantage making possible a much smaller and lighter magnet which out-performs older, direct-acting types. As a result, size and weight are reduced by almost half, while performance, operating efficiency and dependability are greatly improved. Other important "RA" design features include extra-rugged silver cadmium alloy contacts with positively guided travel for perfect alignment . . . and straight-thru wiring for simplified circuit design.

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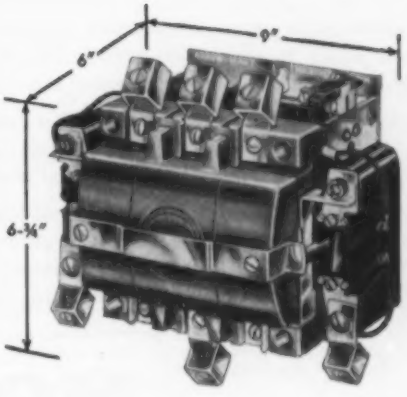

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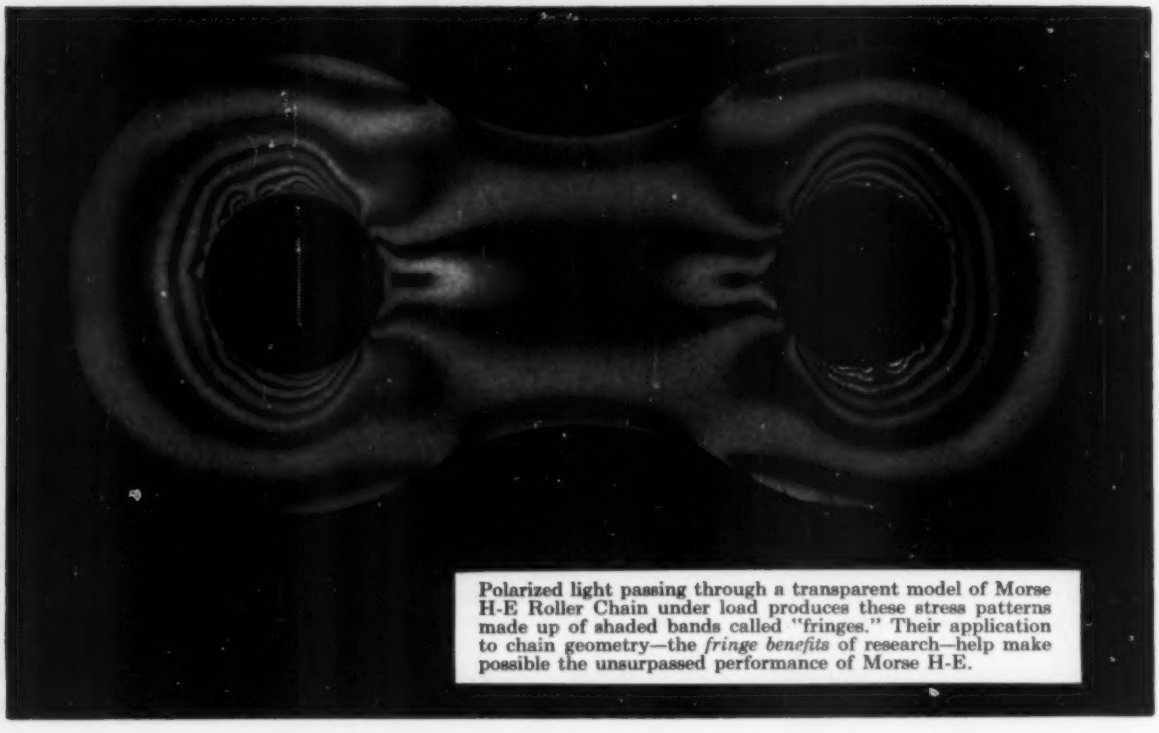

Polarized light passing through a transparent model of Morse H-E Roller Chain under load produces these stress patterns made up of shaded bands called "fringes." Their application to chain geometry—the *fringe benefits* of research—help make possible the unsurpassed performance of Morse H-E.

Photoelastic stress study shows . . .

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Improved design . . . special mechanical and metallurgical processes give Morse H-E a 95% higher endurance limit

"Fringes"—the shaded bands which make up photoelastic patterns—show the intensity and distribution of stresses set up in a chain link-plate model under load. Morse engineers first use this knowledge to improve chain geometry. Then Morse production engineers apply advanced mechanical and metallurgical processes to side plates. Result: Morse High-Endurance Roller Chain, with up to 500% longer life under repeated heavy loadings.

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For full information on research-developed Morse High-Endurance Roller Chain, write: Morse Chain Company, Dept. 4-69, Ithaca, N. Y. Export Sales: Borg-Warner International, Chicago 3, Ill. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ont.

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STAINLESS STEEL FITTINGS for FLEXIBLE HOSE of TEFLON
T-1200
FEMALE–37° SWIVEL 90° ELBOW
ANACONDA flexible connectors of TEFLON
STANDARD HOSE ASSEMBLIES of TEFLON
T-106
Hose Assembly Consists of:
Hose T-1 (page 6)
Fittings T-1100 (page 7)
ANACONDA flexible connectors of TEFLON
STANDARD HOSE ASSEMBLIES of TEFLON
T-100
Hose Assembly Consists of:
Hose T-1 (page 6)
Fittings T-1000 (page 7)
ANACONDA flexible connectors of TEFLON
HOW TO ORDER
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B. Specify Dash Number for Size as (-4)
C. Specify Length in Inches and Eighths of Inches (104 = 10½")
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E. Specify Degree of Clockwise Twist Angle of Elbows.
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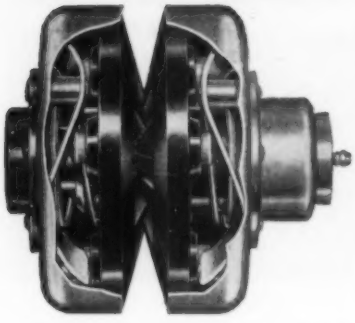
Hi-Lo Load-O-Matic Control Eliminates Pulley Slow Down



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Pulley speed is independent of load and load changes. "Drag" is eliminated and high shock absorbency provided.

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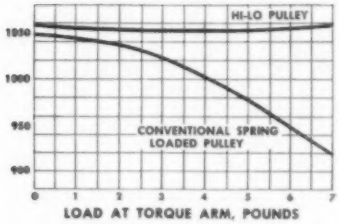
HI-LO PULLEYS COMPARED TO OTHER VARIABLE SPEED PULLEYS



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cation of everyday commercial polymeric products. A chapter on physicochemical behavior also delves into relationship between molecular configuration and differing properties of various polymers.

Modern Foundry Practice

E D HOWARD. Published by Philosophical Library Inc, 15 E 40th St, New York 16. 6 x 9, 464 pp. $15.

This guide to British foundry work is a practical handbook for those who deal specifically with sand castings. Its perspective line drawings are very helpful in the step-by-step visualization of the molding and casting process. The drawings do their job well and they might serve as an example to USA publications. The distinct advantage of line drawings is their ability to point out detail that need to be shown. The text is simply written and readily understood, although the 50 pages on foundry molding sands and dressings do not seem too useful. Unfortunately this book is overpriced for a treatment of such a narrow field.

Modern Transistor Circuits

JOHN M CARROLL. McGraw-Hill Book Co Inc, 327 W 41st St, New York 36. 8½ x 11, 296 pp. $8.50

About 200 transistor circuits are classified and arranged for easy reference, with complete design information and electronic component values. Collection is based on more than 100 recent engineering articles in Electronics.

The circuits are arranged by generic

(Continued on page 147)

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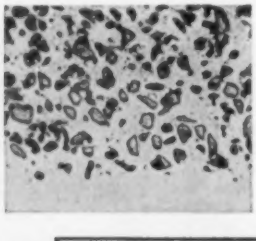

Photomicrograph (25X) shows the tungsten carbide and other smaller hard constituents dispersed in the nickel-base matrix. Relatively clear lower area is base metal. Tests prove Colmonoy No. 75 provides maximum carbide content consistent with good bearing quality, and with maximum deposit efficiency.

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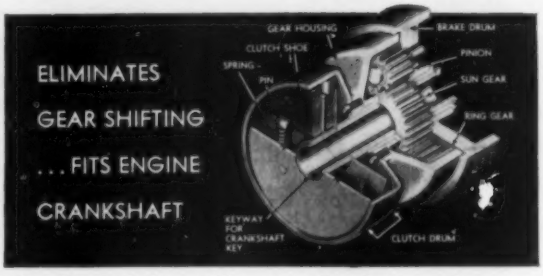

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types (such as amplifiers, oscillators, power supplies, and pulse circuits) as well as by specialized applications (such as broadcast equipment and home entertainment; audio and r-f communication circuits; missile, aircraft and satellite telemetering equipment; test instruments; and industrial, scientific and medical devices).

Emphasis is given to new circuits that combine transistors and electron tubes and transistors and magnetic amplifiers. Includes over 200 schematic diagrams, as well as block diagrams, performance curves, waveforms, and photographs that illustrate construction of equipment.

Flammability Characteristics of Aircraft Hydraulic Fluids

PB131193 (WADC Technical Report 57-151) ZABETAKIS, IMHOF AND LANG, Bureau of Mines. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 29 pp, $1.

The results of spontaneous ignition temperature tests conducted on JP-4 fuel and seven hydraulic fluids in air while in contact with seven surfaces found in aircraft are presented. Tests were conducted at reduced and elevated pressures using both low and high velocity injection techniques. They were conducted between Nov 1, 1956 and Oct 31, 1957. Hydraulic fluids Esso Univis J-43 (Spec MIL-O-5606), MLO 53-446 (General Electric GE 81406), MLO 54-540 (Monsanto OS 45), MLO 54-581, MLO 54-645 (85% Oronite 8200 + 15%

(Continued on page 149)

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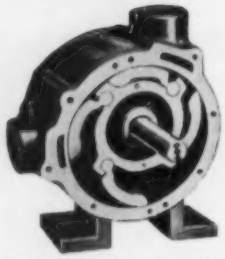
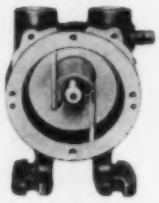


Metal Vanes take up their own wear



4-VANE TYPE. Vacuums to 20" Hg.; pressures to 15 lbs.; displacement to 162 c.f.m. Vanes hinged to pistons maintain continuous sealed contact with cylinder walls by centrifugal force. Small pistons, large air chambers, greater capacity.

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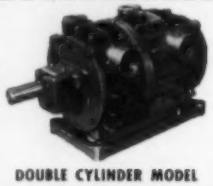

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Plexol), MLO 54-856 (Hollingshead 72073C) and MLO 8200 (Oronite 8200) were tested while in contact with heated aluminum, beryllium-copper, copper, magnesium, pyrex glass, stainless steel and titanium surfaces. In addition, flash and fire points of these fluids were determined in a standard ASTM apparatus.

Shot Peening

Wheelabrator Corp, Mishawaka, Ind. 6 x 9, 193 pp. $2.50.

The sixth edition of this company's textbook has just been revised to include recent developments in continued research on airless blast cleaning equipment. The first part of the book is devoted to applications and advantages of shot peening, as well as the equipment and procedures involved. The second part presents a series of papers by recognized authorities on the theory of prestressed surfaces in relation to shot peening and reviews the history of surface compression methods and their relation to fatigue.

Proceedings of National Electronics Conference

National Electronics Conference Inc, 228 N LaSalle St, Chicago 1. 6¼ x 9¼, 1074 pp plus appendix. $7.50.

Contained in this published volume of the 14th Conference, held in Chicago from Oct 13-15, 1958, are transcripts of papers and discussions presented at the 3-day international meeting. Papers describe developments in a wide range of areas, such

(Continued on page 150)

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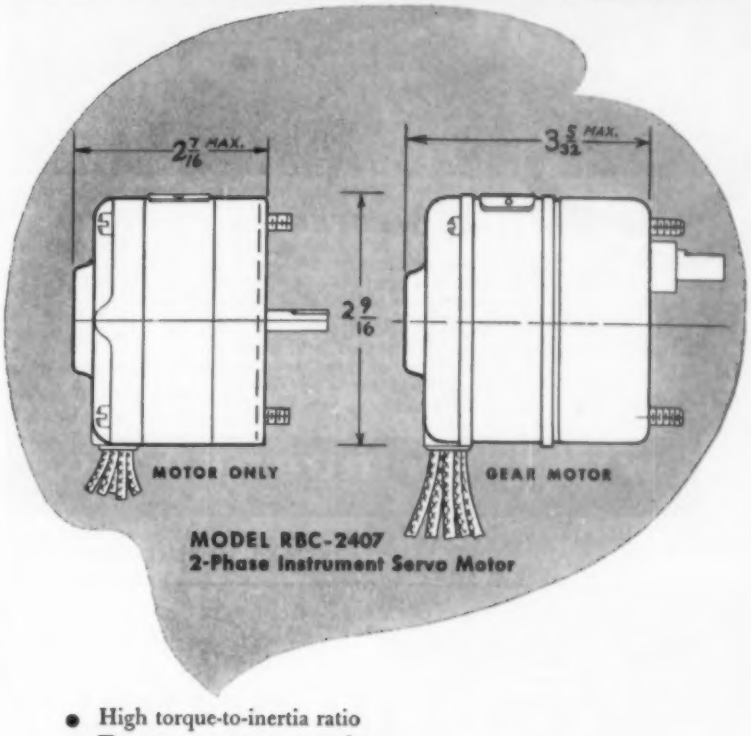

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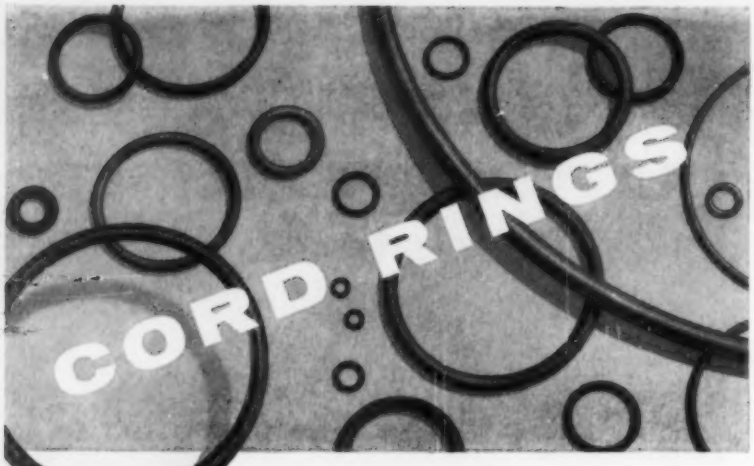

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as transistors, servomechanisms, solid-state components, network theory, instrumentation, computers and industrial electronics; also, papers on engineering management and writing technical reports and speeches. Addresses at the opening session by Gen John Medaris, Donald B Quarles and Dr Simon Ramo are also published in full.

One session reported on writing technical papers, particularly for AIEE and IRE. Papers point out that today writing intelligibly is both a more difficult as well as a more necessary task, and that writing is all the more necessary so that others may share your experience.

Other Books of Interest

Evaluation of Present Understanding of Metal Cutting, Battelle Memorial Institute, Columbus 1.
ASTE Research Fund, 10700 Puritan Ave, Detroit. 8½ x 11, 275 pp. $5, members; $7.50, nonmembers of ASTE.

Engineer's Job Directory, 1959.
Fifth Edition. Decision Inc, 4601 Red Bank Rd, Cincinnati. 8½ x 11, 72 pp. $5.

Policy-making and Executive Action.
T J McNichols. McGraw-Hill Book Co, 330 W 42nd St, New York 36. 6 x 9, 693 pp. $8.
Based on a large number of case histories, presents a discussion of the decision-making process, how decisions are implemented, and some examples of day-to-day demonstration.

Electrical Safety.
H W Swann. Philosophical Library, 15 E 40th St, New York 16. 5¾ x 8¾, 292 pp. $15.
Published in England, discusses causes of electrical accidents, application of regulations, automatic protective devices.

Protective Coatings Specifications.
PB 151166. Office of Technical Services, Dept of Commerce, Washington 25, DC. 6 x 9, 159 pp. $3.

Determining Air Reactions on Moving Vehicles, Part I: Methods of Free Ballistics.
PB 151319. Krzywoblocki. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 132 pp. $2.75.

Semiconductors.
Edited by N B Hannay. Reinhold Publishing Corp, 430 Park Ave, New York 22. 6¼ x 9¼, 767 pp. $15.
Discusses principles, semiconducting materials, properties and applications.

Arc Welding in Machinery Design and Manufacture.
James F Lincoln Arc Welding Foundation, Cleveland 17. 6 x 9, 207 pp. $2.

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Radio Amateur's Handbook.
American Radio Relay League, West Hartford, Conn. 6½ x 9½, 746 pp. $4.
Standard manual of amateur radio communication.

Plastics Industry Exchange Delegation to USSR.
Society of the Plastics Industry Inc, 250 Park Ave, New York 17. 7 x 10½, 61 pp. $2.
This is a report on the visit last year of representatives of the USA plastics industry to the Soviet Union.

Effect of Motion Relationship and Rate of Pointer Movement on Tracking Performance.
PB 131659. J F Gardner. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 21 pp. 75¢.

Spacing of On-Off Controls—I: Push Buttons.
PB 131921. J V Bradley. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 18 pp. 75¢.

Effect of Transfer of Varying Stimulation During Training.
PB 131653. C P Duncan, Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 37 pp. $1.25.

Visual Acuity as Function of Intensity for Different Hues.
PB 131587. J H Berbert. OTS, Dept of Commerce, Washington 25, DC. 8½ x 11, 22 pp. 75¢.

Time Judgments, Acoustic Noise, Judgment Drift.
PB 131767. H J Jerison, J Arginteanu. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 30 pp. $1.

Literature of Space Science and Exploration.
Mildred Benton. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 264 pp.

Creativity—a Comprehensive Bibliography.
Deutsch & Shea Inc, Industrial Relations News Inc, 230 W 41st St, New York 36. 8½ x 11, 16 pp. $2.

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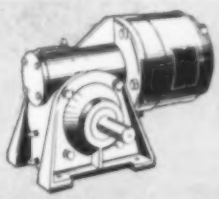

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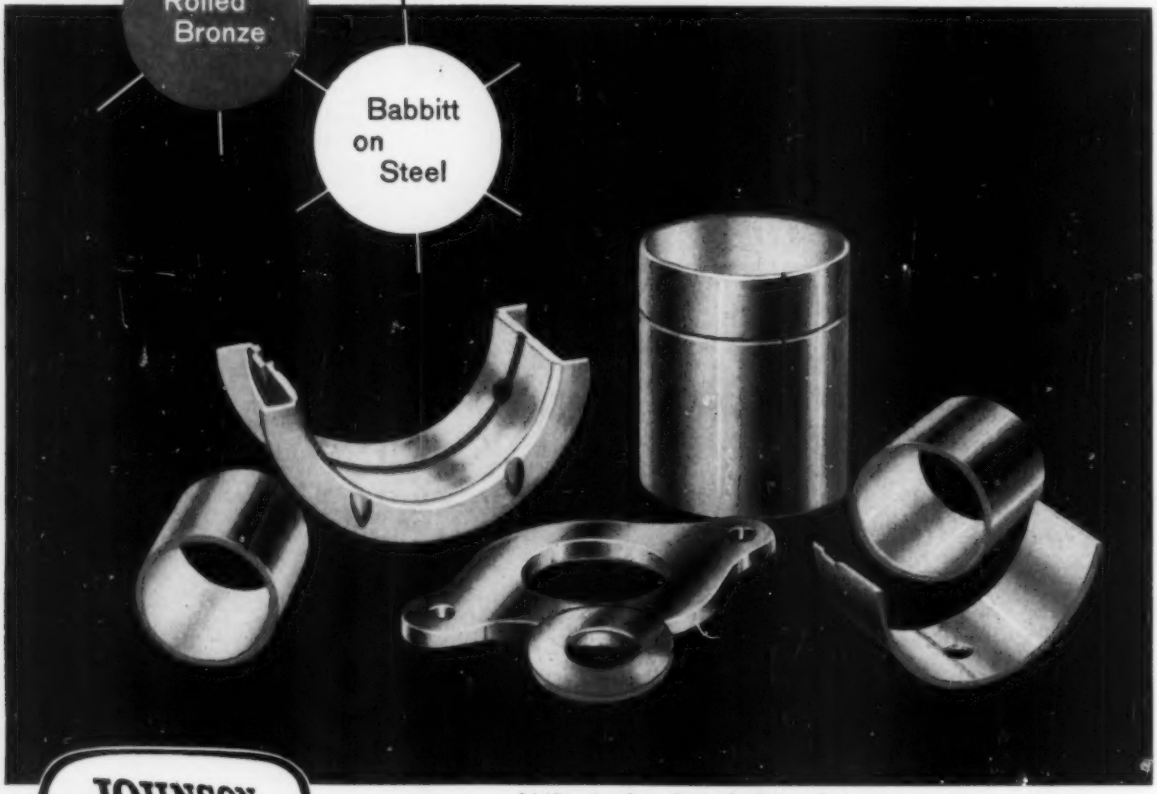

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CIRCLE NO. 202 READER SERVICE CARD

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Cutaway view shows the Dodge All-Steel pillow block with Timken bearing mounting. Of special design, the bearing has a tapered bore with self-aligning spherical outer surface —never needs adjustment.

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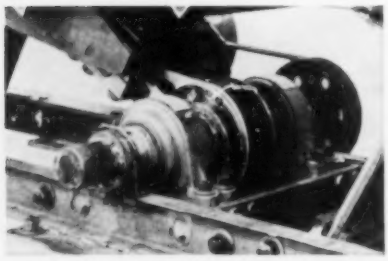
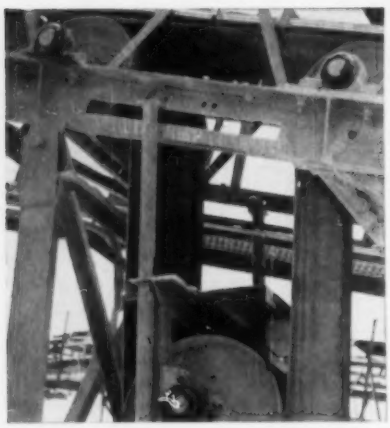
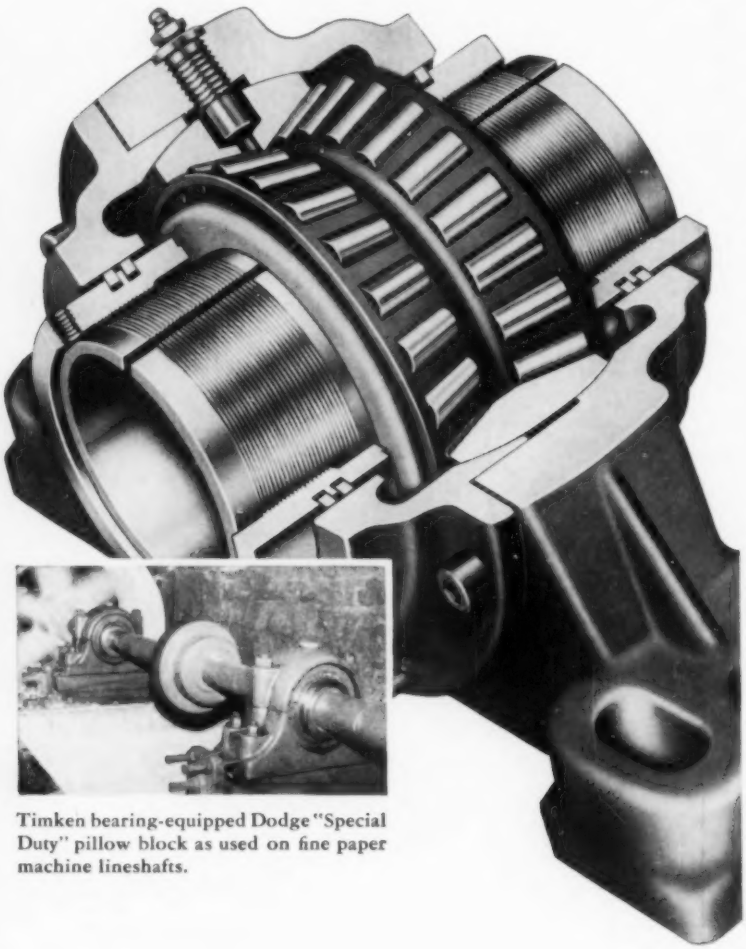


Timken bearing-equipped Dodge All-Steel pillow block used in a vibrating conveyor.



Timken bearing-equipped Dodge Type "E" pillow block used in sand and gravel plant.



Timken bearing-equipped Dodge "Special Duty" pillow block as used on fine paper machine lineshafts.

TIMKEN

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CIRCLE NO. 203 READER SERVICE CARD